COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. xx | JULY, 1915. | No 7

Jackhamering on the John D. Rockefeller Estate, Pocantico Hills, N. Y.

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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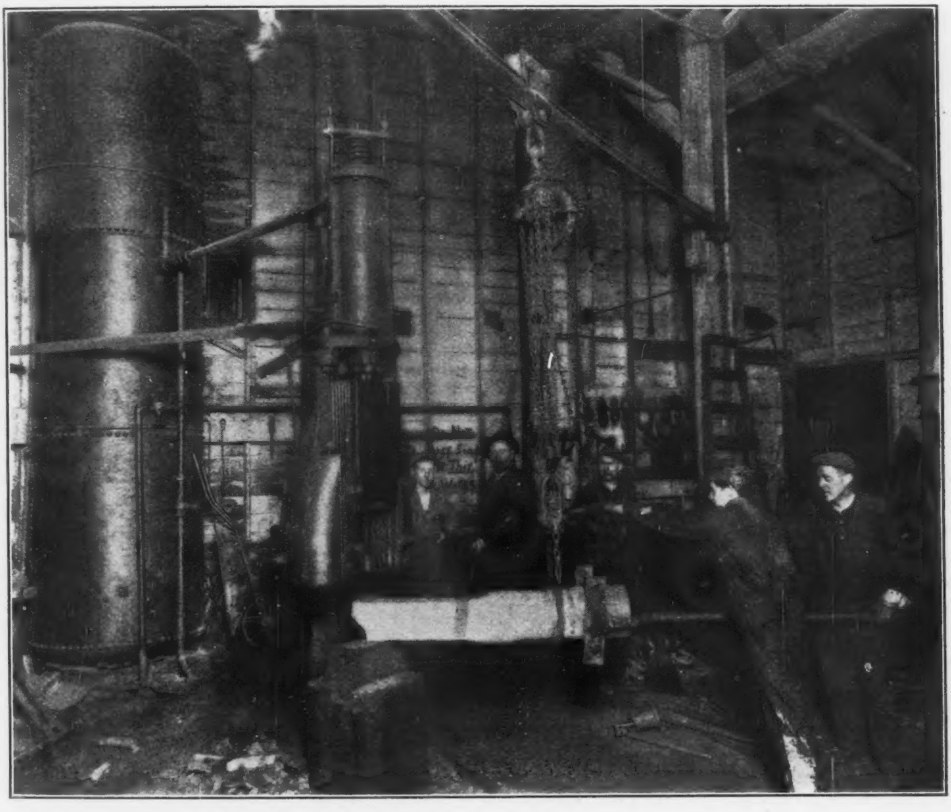


FIG. 1.

ELECTRIFYING THE FORGE SHOP

BY CHARLES A. HIRSCHBERG.

This is to tell how steam may be, and is being, dispensed with as a direct motive power in forge shops, the electric current being adopted in its place, and this being made available by the aid of compressed air. We may begin by citing one plant, Buffalo Pitts Co., Buffalo, N. Y., where the substitution was actually made, that is, a steam hammer was converted into an electro-pneumatic one.

Inquiry was made here as to the reasons for the conversion and whether the results had justified the change. It elicited the following reply:

"We have one forge hammer operating un-

der compressed air. It has been very satisfactory but we are sorry that we cannot give you at this time any accurate information as to the amount of power which it takes to operate it."

"The principal reason why we changed from steam was that our boilers were being run here for the sole purpose of operating our one big steam hammer, the rest of the plant being on electric power. By cutting off the steam we have been able to cut out our high-pressure boilers."

The compressed air plant here consists of a motor driven "Imperial" two-stage compressor, and the air in addition to driving the hammer is being used for operating pneumatic portable shop tools.

The Nisqually-Russell Car and Locomotive Works of Tacoma, Wash., were also operating their forging hammers by compressed air, and upon inquiry Mr. A. G. Brown, President and Manager, was good enough to furnish some extremely interesting information and the accompanying photos.

About two years ago (1912) the City Boiler Inspector condemned the boiler in this plant. It was chiefly used to furnish steam for the large hammer shown in Fig. 1. Instead of buying a new boiler the old one was converted into a vertical air receiver and a 14 and 9 x12 "Imperial" air compressor was belted to motor installed to furnish power to the hammer as well as to operate the hand air tools used about the works. The receiver is placed close to the hammer as shown. In converting the steam hammer to compressed air operation the action of the inlet and exhaust valves was improved by giving them a slight taper.

In Fig. 2 is shown the compressor plant, although the relative dimensions are not consistent. Mr. Brown stated that $50.00 a month was a liberal estimate for the power consumption of the compressor, whereas the fixed charges under the old system were $62.50 per month for the licensed fireman at $2.50 per day and $31.25 for 12½ tons of coal at $2.50 per ton, making a total of $93.75, or a saving in favor of the air compressor of $43.75 a month.

The reader should bear in mind that the compressor is operating other tools; therefore the saving in reality would be greater than the figures above show. On the above basis, however, the saving per year in this plant is $525.00. This company further stated that aside from the saving there is a decided advantage in the increased efficiency of the hammer as they were only able to carry 90 lbs. pressure on the old boiler and they figured that this gave them about 60 lbs. working pressure at the hammer. The air, on the other hand, is practically at the same pressure at the hammer as in the receiver, and they get fully 90 lbs. on the piston. The further statement is made that "the air is quicker, and although not so elastic as the steam (?) is nevertheless very satisfactory."

A further saving might be mentioned in the expense of handling the ashes which they have to cart away. So far as the item of cost for boiler feed water is concerned, this is about offset by the consumption of the cooling jackets of the compressor.

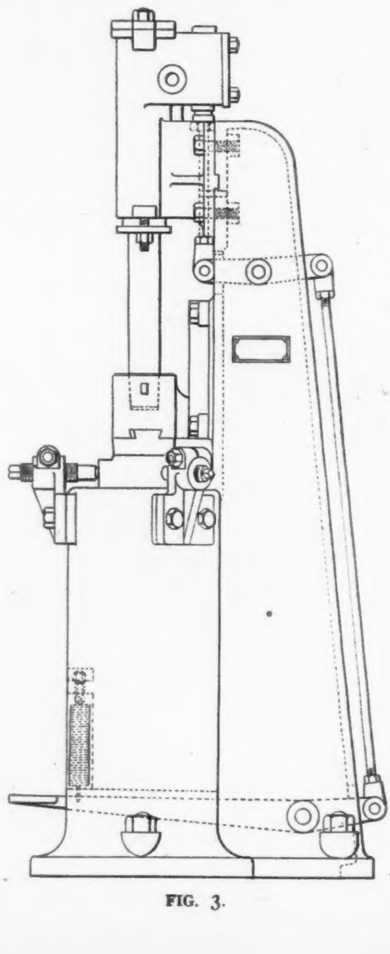


FIG. 3.

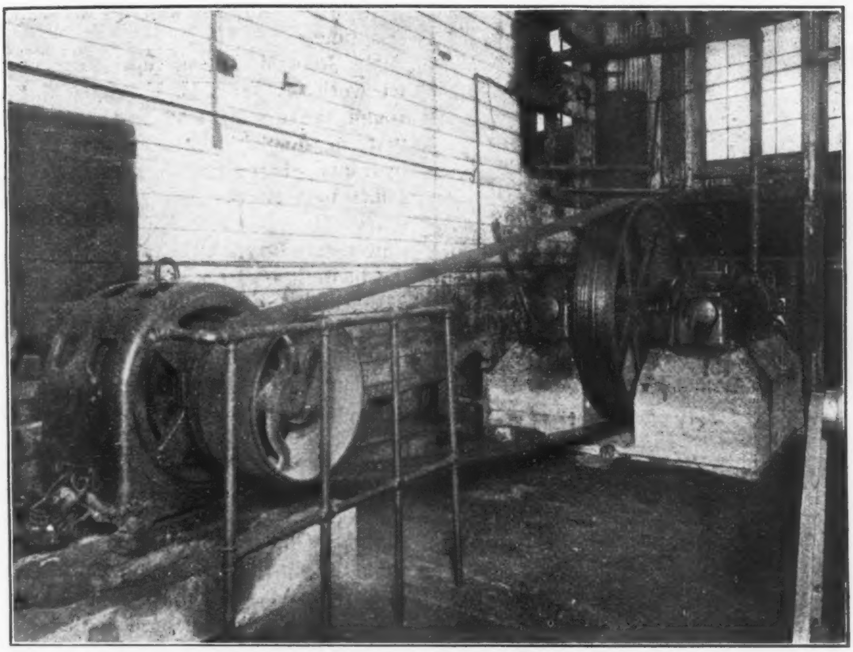


FIG. 2.

The Herbrand Company of Fremont, Ohio, have recently installed several compressors for operating converted steam hammers; they have not however been long enough in service to draw a comparison between present and past practice.

Manufacturers of forging hammers have become awake to the conditions existing and within the past few years there have been a number of hammers placed on the market designed especially for operation by compressed air.

In Fig. 3 is shown a pneumatic drop press built by the Henderson Machine Co., of Philadelphia. It is designed for stamping sheet metal hot. Sizes range up to 46" x 72" face of hammer. The power consumption ranges from 60 cubic feet of free air per minute, for the smallest size, to 200 cubic feet for the largest at a pressure of 90 pounds.

Fig. 4 shows another pneumatic drop hammer, built by the Pennsylvania Pneumatic Co., Erie, Pa. The builder's object in designing this tool was to eliminate the board, friction rollers, gears, clutches and other such appurtenances which mark the ordinary steam drop hammer, and to take advantage of the convenient compressed air power, making it possible to greatly simplify the design and in addition give more satisfactory operation. Compressed air at a pressure of 60 to 100 lb. is used, striking a blow of between 250 and 350 lb. The manufacturer claims an unusually low air consumption of about 3 cu. ft. of free air per minute at 60 lbs. pressure or about 5 cu. ft at 100 lbs. pressure.

A FEW ADVANTAGES OF THE PNEUMATICALLY OPERATED HAMMER AND DISADVANTAGES OF STEAM OPERATION.

Compressed air is lively and instantly available for use, so that there is no delay when starting up in the morning, or any time it may be wanted.

When starting up the steam hammer it is usually cold and the steam condenses, the lubrication is partly washed out, and there is a lot of water dripping, so that you cannot put a forging under the hammer at once. If you do that, dripping water is likely to spatter and scald the operator. Nor can the forging always be left in the fire, waiting for the water to stop dripping, because it is liable to burn, and all this trouble happens several times a day unless the hammer is in constant use. Then there is constant trouble from burnt out packing.

FIG. 4.

OTHER USES FOR AIR IN THE FORGE SHOP.

In many forge shops the compressed air is utilized for blowing forges, oil furnaces and tempering furnaces, for agitating various tempering liquids, for operating hoists, bull-dozers, bending presses, bolt heading machines and various other pneumatic devices and portable pneumatic tools.

The average machine shop is already familiar with the advantages of compressed air in shop operations, but in the case of the forge shop it would seem to warrant special consideration.

LEAD WOOL AND PNEUMATIC CAULKING

At the recent annual meeting of the American Water Works Association the comparative merits of lead wool and of cast lead joints were discussed, and it was shown to be greatly advantageous to use the lead wool, especially where only a few joints are to be made at a time.

Mr. John M. Diven, superintendent of water works at Troy, N. Y., stated that he has found the use of lead wool so satisfactory that, in small jobs, such as in setting fire hydrants where there are only four or five joints to make, he has not used a fire for years. He called attention to the fact that the time required to get the fire started and to get the melting apparatus in position, in the case of a small job, is a large percentage of the time required for the entire job, and is correspondingly expensive. On one large job he stipulated with the contractor that a half mile of pipe be laid with lead wool and hand caulked joints and a mile with air pressure joints. A careful record of the leaks in both types of joints was to have been kept, but the contractor's caulkers refused to do the work and the test was given up.

This is not the first instance in which caulkers have refused to use the pneumatic tools. The refusals have not been at the suggestion of "organized labor" or anything of that kind, but have been on account of the inexperience and timidity of the workmen. Where the use of the pneumatic tools has been demonstrated by experts, and where it has thus been shown that the work is actually easier and more remunerative the tools have come to be preferred, as has occurred in Brooklyn and elsewhere.

On another occasion Mr. Diven states that he had laid an 8-in. cast iron pipe line through swampy land. One-half of this line was caulked with lead wool and the other half with cast lead joints. Seven or eight months after the work was done there had been no leaks in the lead wool joints but all of the cast lead joints had developed leaks. The joints were all very deep and were from ½ to ¾ in. thick, and the lead wool held where the cast lead did not.

Mr. Oscar Bulkley, engineer of the Rockford, Ill., water department, stated that in his department lead wool was used on a line of pipe 8 and 10 ins. in diameter, but the use of the material was abandoned because the caulkers refused to do the work. When caulked by hand it is a long and tedious job. The only way lead wool can be used to advantage on big jobs, is in connection with pneumatic caulking.

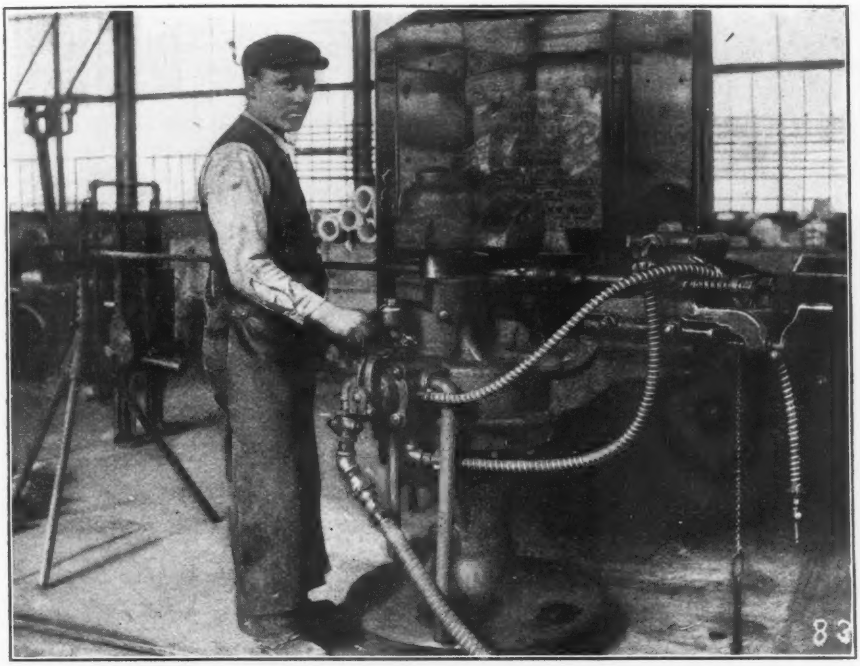


FIG. I. GENERAL VIEW OF LEYNER SHARPENER.

JACKHAMERS DRIVE GANGWAYS IN ANTHRACITE MINES

BY CHARLES C. PHELPS.

This article refers to the results obtained in mining anthracite coal by the use of Jackhamers and electrically driven mine-car compressors by one of the large coal-mining companies operating in the Scranton district of Pennsylvania. One of the collieries of this company was recently visited by the writer after the above-named equipment had been in service about seven months.

The mine car compressors employed here are of the Ingersoll-Rand type, and the Jackhamers also are Ingersoll-Rand B. C. R.-430, both of which have been described in these columns and elsewhere, so that it will not be necessary to go into a detailed description again. A large number of these equipments are in use in the various mines of this company for drilling both coal and rock, also for cutting hitches for timbers.

Formerly hand coal augers were used for boring the coal, while Temple-Ingersoll electric-air drills, as well as hammer and "jumper" steel, were employed for the rock. Whereas two men were required for either machine or hand drilling, as formerly practiced at this mine, it now requires but one man to run a Jackhamer drill, as this machine is easy to operate and, owing to its lightness, may be moved from place to place almost as easily as a shovel or a pick.

One feature of the Jackhamer that is particularly appreciated by the drill runner is the improvement in the ventilation at the face due to the air exhausting from the drill.

Although some of the holes are drilled downward, most of them are projected horizontally for blasting from the solid. Probably three out of every four holes are horizontal. The blast holes are drilled to a depth of 6 ft. with changes of steel varying by a foot. A set comprises lengths of 2½, 3½, 4½, 5½ and 6½ ft. of hollow hexagon steel with cross-bits of such size that the bottoming diameter permits charging with ⅞-in. 50-per cent. gelatin powder. Holes were formerly put in to the same depth and the same strength powder was used, but the holes were of 1½ in. diameter.

With conditions as mentioned above, the rate of progress during one month was 225 ft. of gangway driven,. working with one Jack-

hamer during two 8-hr. shifts per day and driving a section 14 ft. wide comprising 3 ft. of anthracite coal and 4 ft. of bottom sand-rock. The rate of drilling of the Jackhamer in hard coal was observed to be 3 min. for a 6-ft. hole, including changes of steel. It required 10 min. to drill a 6-ft. hole in the sand rock, also including the changing of steel.

The mine-car compressor is transported over the regular mine tracks to a point near the face. It is then derailed and placed to one side and connected with the electric line supplying the trolley system. The drill-runner also cares for the mine-car compressor, no other attendant being required. In fact, about the only attention required by the compressor is an occasional filling of the water jacket, which is of the hopper reservoir type, and replenishment of lubricating oil. In other respects the compressor is entirely automatic in action, an automatic unloader keeping the pressure in the receiver at approximately 100 lb.

The 25-hp. motor which drives this compressor is started and stopped with an automatic motor starter, which is a new development, as hand-operated starters have been employed previously for starting machines in this service. The hand starter has the shortcoming that it depends for successful operation upon a certain amount of skill on the part of the operator, and as these equipments are often handled by inexperienced men, it is difficult to prevent abusing the motor when the hand type of starter is employed. With the automatic starter, the knife switch is closed in order to start up, whereupon the motor is smoothly but quickly accelerated to maximum speed. The knife switch is opened when the compressor is to be shut down.

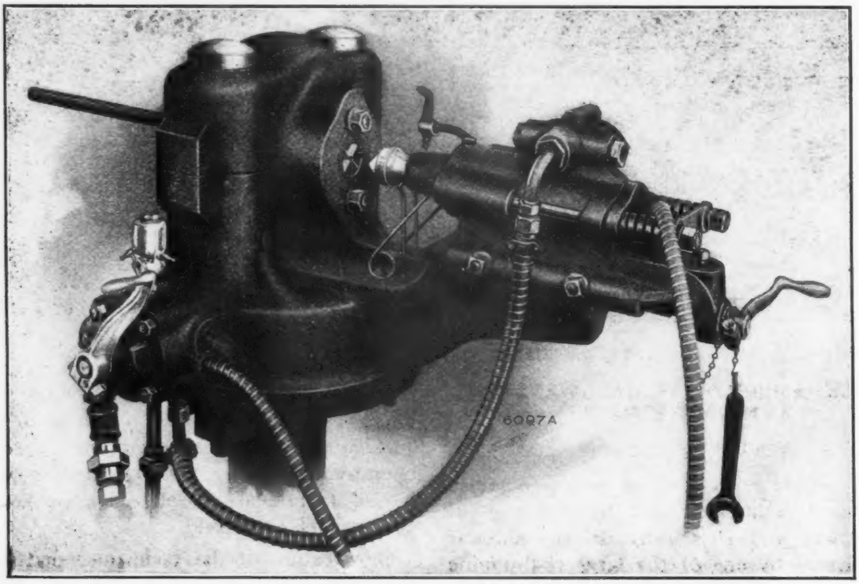


FIG. 2. DOLLY SHARPENING A DRILL POINT.

The automatic motor starter may be seen in Fig. 3 showing the compressor car. It is known as a form AK made by the Electric Controller & Manufacturing Co. The copper contacts are protected by dirt-proof covers, which also help to exclude the corrosive gases that are present in coal mines. On account of the extremely wide range of voltage found in the average mine these starters are specially designed to keep the motor across the line, even when the voltage drops to a very low figure. An added advantage of using automatic starters lies in the fact that if power is interrupted the motor will be gradually restarted without further attention when current is again restored.

The steels used while making the observations referred to were sharpened by hand. Since that time several Leyner drill sharpeners have been purchased for the company's

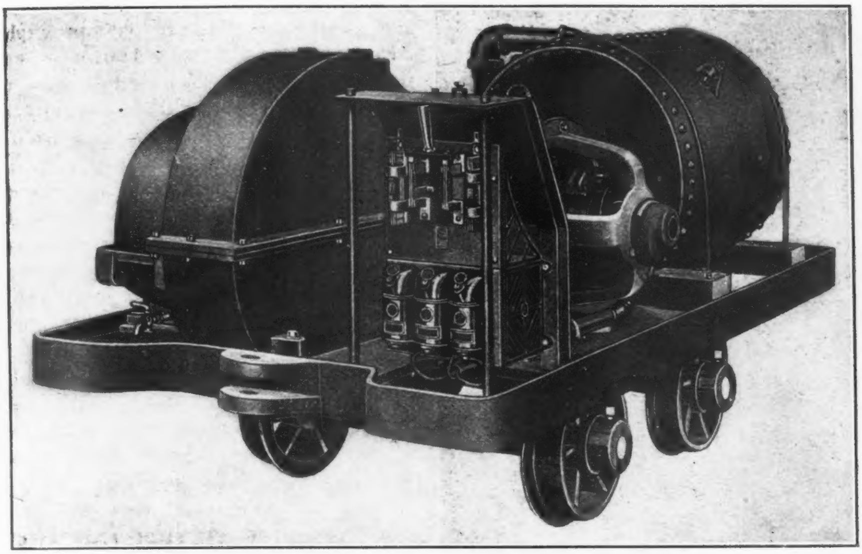


FIG. 3. MINE-CAR COMPRESSOR WITH AUTOMATIC STARTER.

various mines. One of these is shown in Fig. 2. Three coal forges located near the sharpener are used for heating the steels. The bit is first inserted between the forming blocks, and the heavy cross-head forges the bit to approximate cross-section. It is then inserted in the dies in the center of the machine and the cross-head is lowered to grip the steel tightly. The dolly then reciprocates rapidly, striking the end of the bit a succession of light blows, compacting the metal and sharpening the bit.

The sharpener is operated by compressed air, and its action is controlled entirely by the single lever shown in the illustration. After sharpening, the steel is reheated to a cherry red and hardened by dipping in a pail of water upon the surface of which floats about ½ in. of crude oil. The shanks are formed in the same machine and are hardened for a distance of about ¼ in. from the end.

By means of the Leyner sharpener the time required for sharpening steel is greatly decreased, giving the blacksmith more time for other duties. At the same time a much better and more uniform quality of work is obtained. The method of hardening described has proven satisfactory, resulting in very little broken steel.—*Coal Age.*

Tanks to hold half a ton of ice and electric fans to circulate the air from them are used to cool the interior of passenger cars of the Egyptian State railways.

POWDER EXPLOSION PHENOMENA.

It is curious how differently powder acts under conditions apparently similar. I have been at the side of a man carrying a box of powder, when it fell and did not explode. Again, I have known it to fall from a man's shoulder and kill every one near-by. I once had a mule loaded with grain and 100 lb. of powder; the cargo became loose and frightened the mule, which ran away, scattering the powder for a hundred yards and even breaking sticks of it, but without any explosion. A number of years ago a pack-train of 22 mules loaded with powder out from Mazatlan, Mexico, disappeared. It is presumed a box fell off when loading. At any rate the whole pack-train, including the men, was killed. The remains proved insufficient for burial.

Once a partner of mine was thawing powder at an open-air fire while we were eating dinner. It caught fire and as we needed that powder badly, he grabbed a shovel and deliberately beat the fire out with it. I yelled, trying my best to stop him, and then, as he kept on, I ran; but there was no explosion. Later his carelessness caused the loss of his eyesight. While working in a 240-ft. tunnel we tried to fire six holes at the breast. One would not spit and, after lighting the others, we again tried to ignite it, but were finally obliged to run. The fuse still declined to spit, and the result was a misfire. My partner insisted on returning (probably 6 to 8 minutes

FIG. 4. STARTING A HOLE.

later) to re-light it, while I built a fire to warm our coffee. I tried my best to persuade him to wait until after dinner, but he went and was just over the hole when it exploded. This fuse, examined afterward, showed no evidence of having been burnt.

A friend had an experience with defective fuse in the bottom of a shaft. The fuse would not light. He and the others waited the full noon-hour, when, upon entering the shaft, it exploded. I have known an ignorant man to throw powder down a 40-ft. shaft to a miner without its exploding. That miner, however, did explode; climbing the ladder, he chased the other man off the property. The latter never returned. I have seen boxes of powder thrown down a bank, 60 to 75 ft. high, sometimes breaking the boxes, and still without exploding. I have seen loose sticks thrown from one car to another loaded with rocks and bounce off the car without exploding. Again, powder has been known to explode from a very slight shock or fall.

I have seen two or three tons of powder burn up without explosion and again have seen it explode from the heat of a stove while being thawed. A few years ago a ship-load was lost at the entrance to the Bay of Altata, at Sinaloa, Mexico, and after several months it was salvaged. It was so badly damaged that new powder had to be used with it in order to make it explode, but, the price of powder being high, it was all used.

The action under similar conditions of powder of the same make and strength is so different, that the utmost care should always be exercised when handling any explosive.—*G. L. Sheldon in Mining Press.*

AN EXPLOSIVE MIXTURE AND WHAT IT DID

BY NAT. G. PUMPER.

There was a compressed air tank used by a large pumping plant to start their gas engines. The tank, which was located outside the auxiliary room, was 60 in. diameter and 20 ft. long, tested to 200 lb., the compressor for charging was too small for the purposes and in an emergency a one-inch line from the high-pressure gas line was tapped in. The tank would be charged up to about 130 lb. and the engine started, then the tank would be blown clean and filled with air by the compressor.

This went very well for awhile, but one day the auxiliary engineer blew the tank down to atmospheric pressure, closed the outlet valve and proceeded to pump with air till he had 130 lb. gage and a beautiful mixture in that tank. A few hours later, another engine was to be started, everything was ready, the "air" was turned on, ignition switch pushed in and then one of the starting valves stuck open. That tank started 3 ways at once, the middle sheet straightened out flat and went about 4 ft. into the ground, cutting off a 10-in. line, one end started east, taking a 6-in. engine feed line with it and the other end went the other direction, landing in a bank of 16-in. gate valves which it demolished. A large farm house 120 yards away was moved off its foundation and the plant was wrecked generally, and now they start with air.—*Practical Engineer.*

COMPRESSED AIR FOR FLOATING AND REPAIRING STRANDED SHIPS

BY HERBERT B. SAUNDERS.

It has been my privilege during the last twenty years to be very closely associated with salvage work, and during this period I have been able to observe very closely the different methods that have been employed by several salvage contractors as they have wrestled with the difficult engineering problems. Some have employed methods which were very crude and even amusing, while others have gone to work with a skill and energy which have produced most remarkable results. Probably the method which has appealed to me more than any other has been the use of compressed air, not only with ordinary salvage operations but for construction work such as the laying of foundations by the aid of the pneumatic caisson.

THE SCOTTISH KING.

Some sixteen years ago the steamer Scottish King, on a voyage from Antwerp to Baltimore and laden with a valuable cargo, stranded on the eastern shore of Newfoundland. Various efforts were made by local companies to release her, but with no success. Then Captain William Leslie of Kingston, Ontario, came with the wrecking steamer Petrel which had an air compressor as part of her equipment, and by its aid, in combination with that of powerful water pumps, the vessel was floated and taken into St. Johns, where she was temporarily repaired and sent to the St. Lawrence. There she loaded a cargo of lumber for the United Kingdom, but due to various mishaps the venture was not a financial success, and so for the time being enthusiasm over the salvage means employed was dampened.

I had carefully watched what had been done by Captain Leslie and was impressed by the methods employed, but also that these methods could be improved so as to secure economy and despatch. It will be readily appreciated, however, that opportunities in this line are not frequent, and that improvement depending upon actual experiment must be slow.

The next case which presented itself was upon a large steamer that stranded in the West Indies, and the only apparatus available was a hand operated diver's air pump. The forward compartments were full of water to sea level. The air hose was attached to the air pipe at the forward end of the tank and

FIG. I. SCOTTISH KING, NEWFOUNDLAND, 1899

in a very short time the trouble was found. The diver was sent down, the holes were plugged and the compartment pumped out. In a short time the other damaged parts of the vessel were located from the outside, stopped, tanks pumped out and valuable vessel was saved.

Shortly after this the British steamer Ben Cruachan while on a voyage to the St. Lawrence stranded to the eastward of Louisburg, C. B., harbor. It was high water when she stranded and blowing a fresh S. E. gale, so that the vessel was forced well up on the rocks. I succeeded in persuading the contractor to apply compressed air as the main agent in saving this vessel. He brought his plant alongside the ship at noon on Friday and the following Tuesday evening all was ready for trial. The preliminary tests were successful, so that when the air was applied the next morning at high tide the vessel was readily released from her rocky bed. She was taken into Louisburg where sundry repairs were made and the next day she was able to proceed under her own steam to Halifax, and there she was dry-docked and repaired and turned over to her owners in as good condition as before the mishap.

The next experience in this line and equally satisfactory was with a large Italian steamer

on the Florida Keys. It was nearly a repetition of the work done on the Ben Cruachan.

The author of this paper having watched the work done by the different experts and seen the advantage of compressed air for this service, has continued experiments and applied certain improvements in practice.

When the water has been expelled by the pressure of the air and a patch is to be applied from within over a wound by which the water has entered there usually is at this point a violent pulsation between the air inside and the water outside, which makes it practically impossible to get concrete, or any other kind of jointing material to set properly. The surging causes the concrete to become honeycombed, with the result that the patch thus applied is considerably weakened, and often when the air pressure is removed the patch all gives way, and the work has to be done all over again.

This trouble so serious and often so costly to the contractors is overcome by the simple method here outlined. A piece of large pipe is provided (Fig. 2) threaded on each end with one end screwed into a large flange and a cap ready to be screwed on to the other end. The water having been expelled by the compressed air, and the air pressure being maintained within the compartment, a sheet of lead, forming an apron is spread over the wound, overlapping it all around, and then the flange is placed over the lead and secured from moving by wooden dowel pins. A hole is punched through the lead right at the wound so that the water outside has free communication with the interior of the pipe, the upper end of the pipe remaining open.

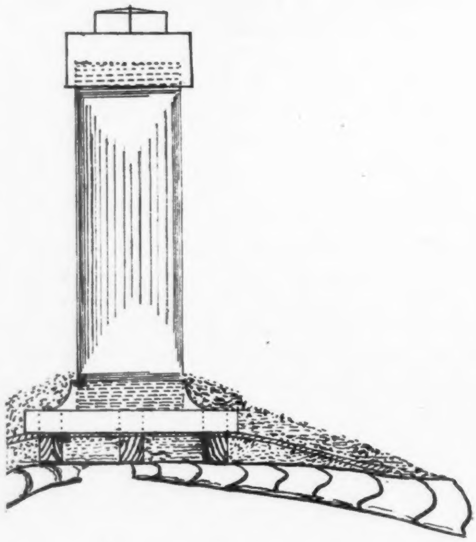
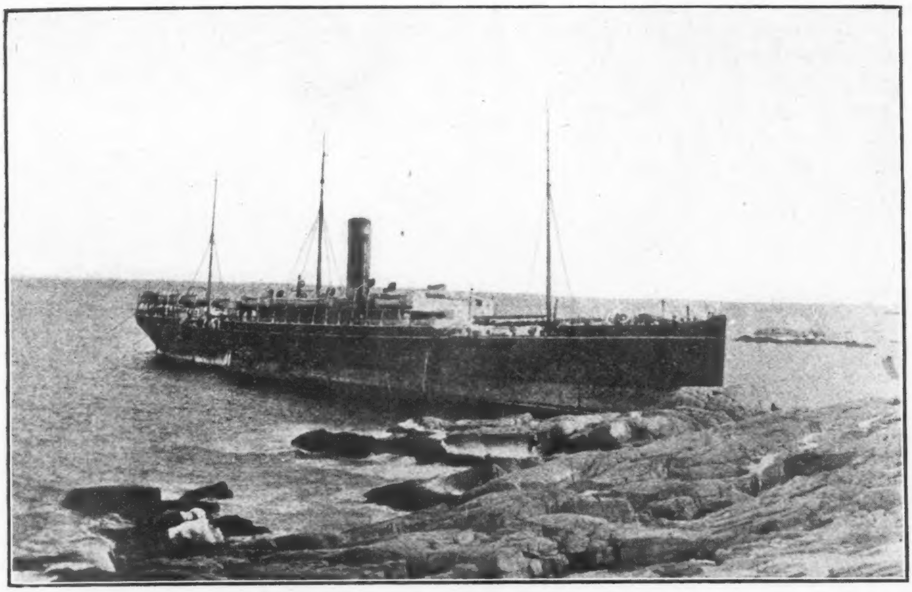


FIG. 2.

Concrete is then applied over the entire patch, starting at a reasonable distance out-

ROYAL GEORGE, ORLEANS ISLAND, 1912.



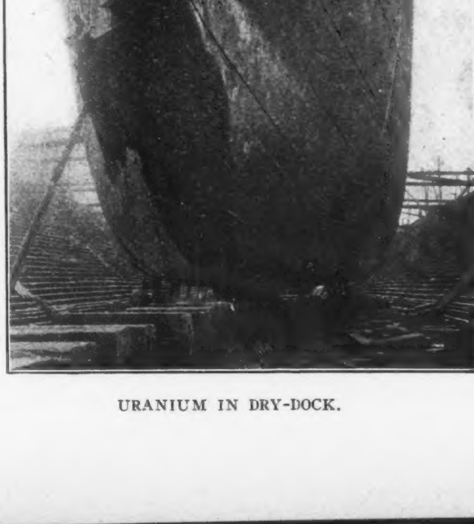
URANIUM, CHEBUCTO HEAD NEAR HALIFAX.

side the water edge of the lead apron and working in toward and around the pipe, and as thick as may be required to insure sure resisting power against the upward pressure that must come against it as soon as the internal air pressure is removed. The pipe referred to can be used singly or in series, according to the size of the wound and the thickness of the patch. When the concrete has securely set the caps must be screwed on to the upper end of the equalizing pipe or pipes, this effectually preventing the inrush of water.

The next point to be overcome was the fogging caused by the heated air being forced into the compartment under pressure. This was taken care of by an effective aftercooler which reduced the temperature after compression so that the air was comparatively dry and free from fog.

The results obtained were satisfactory, for previous to these experiments great trouble was experienced from the starting of the deck joints caused by the sudden rising and falling of the temperature and pressure, and the unsatisfactory work that was done under the difficult conditions.

We can now refer to the salving of the Royal George (Fig. 3), a mail and passenger steamer of about eleven thousand tons register operated between the St. Lawrence and Bristol, G. B., by the Canadian Northern Steamships, Ltd. This vessel stranded on her last, 1912, voyage to Montreal, a short distance below Quebec. Various efforts were made to release the vessel which was seriously damaged and forced well up on to the rocks of Orleans Island, but the owners abandoned their interest in the vessel to the underwriters



URANIUM IN DRY-DOCK.

and their experts employing the methods here outlined soon released the vessel. There were several patches put on from the inside which allowed several of the compartments to be pumped out and then she was floated. Later she went into dry dock and proper patches were put on the outside.

The next case, more difficult and trying, was that of the S. S. Uranium. This vessel stranded, early in 1913, in the vicinity of Chebucto Head at the entrance to Halifax Harbor (Fig. 4). She was severely damaged from her stern to the second transverse bulkhead but was successfully floated and taken into Halifax, where as no dry dock was available she was so patched *from the inside* by the aid of compressed air and the system of concrete patching that she was able to reach New York under her own steam. Fig. 5 shows the bow of the steamer in Robbin's Dry Dock, South Brooklyn, where she was properly repaired.

LIQUID AIR AS AN EXPLOSIVE

The following is an abstract, presented in the Journal of the American Society of Mechanical Engineers from *Zeits. für Eis—und Kälte—Industrie.*

Professor Linde appears to have been the first to successfully introduce an explosive consisting of ground charcoal and liquid air. Since then Claude and d'Arsonval, in France, have further developed these processes, and finally Kowatsch and Baldus, in Germany, have lately worked it out still more fully, partly under the pressure of the present demand for an explosive exclusively of German manufacture.

In order to avoid excessively rapid evaporation of the liquid air, Kowatsch, who uses a cardboard cartridge, introduces first a cartridge with dry carbon into the drill hole separately and without any liquid air, which is put in only just previous to ignition. The process permits reducing to a minimum the period of evaporation, and also increases the factor of safety of operation.

The cardboard cartridge contains a perforated pipe in which there is a mixture of infusorial earth with oil and asphaltum or lamp black and parafin, neither of which is explosive in itself. This center pipe contains another cardboard tube over which a third cardboard tube is set, serving as an exhaust pipe for the products of evaporation of liquid air. If several drill holes have to be exploded simultaneously, the electric connections are made accordingly.

The liquid air which has to be used for each hole is kept in a precisely determined quantity in a small bottle, the opening of which is provided with a metal tube and conical nozzle, connected with the central tube of the cartridge. To load the cartridge, all that is necessary is to lift the rear end of the bottle. The liquid air is raised by the pressure of its own products of evaporation and gradually passes into the cartridge. At the instant when the charge is ignited by the electric spark, the liquid air combines with the charge and there follows an explosion of exceptional violence.

Among the advantages of this method of explosion is the fact that, in the first instance, the materials used are not explosive in themselves and the explosive mixture is formed only at the very last moment in the bore hole itself. In the second place, should an explosion be missed, the liquid air will evaporate and the remaining cartridge is perfectly harmless.

SAILOR'S LIFE SAVED BY OXYACETYLENE TORCH

When the salvage ship "Salvor I" turned turtle off the English coast near Yarmouth, all the crew were washed away and drowned except one man who found himself uninjured but imprisoned in the forecastle. The vessel had turned so quickly that there was plenty of air impounded, so he was in no immediate danger of drowning or suffocating. Every time the vessel rose with the swell one of the portholes rose clear of the water, and, stationing himself at the opening, the imprisoned man stuck his arm out and waved his hand each time this occurred. After three hours he heard a slight tapping on the hull, a head was stuck in at the porthole and a voice said "Where shall I cut open the hull?" After showing the rescuers how to keep clear of the stancions the imprisoned man lost consciousness, but had a vague realization of being gripped by the neck later and pulled out of the hull. An opening big enough to pull the man through had been cut in the steel hull with an oxyacetylene torch, the rescuers standing neck-deep in water for an hour while doing this work.

DANGERS AND SAFETY CONDITIONS OF HIGH EXPLOSIVES

The detonation of nitro-glycerine and its compounds, among which the best known are dynamite and gelatine-dynamite, can only be brought about by one of the two following causes: First, the elevation of the temperature of the nitro-glycerine to its explosive point, namely, in the neighborhood of 400° F., but this does not apply to the entire mass of the nitro-glycerine; it is only necessary for the smallest particle of nitro-glycerine. The heat liberated by the explosion of this smallest particle is quickly communicated to the adjacent particles and progressing with lightning rapidity, in geometric ratio, detonates the entire mass as if by a single impulse. Second, by the synchronous vibrations responding to a wave of detonation set in motion by an exploding mass of nitro-glycerine. This second cause may perhaps be referred to the first; for sound, heat, and light are all forms of energy and are convertible.

Strange stories are often told regarding the erratic behavior of dynamite, and a veil of mystery is generally thrown about the resulting accidents. These stories are often correct, but there is no mystery. It must be borne in mind that dynamites, even those of the same grade or degree of strength, are often not the same, that is, they differ in composition. Again dynamites of identical grade and composition often differ as to their physical properties. For instance, take two dynamites of the same composition, in the one that is the drier the "dope" ingredients are further away from the saturation point; this will render it less sensitive than the other.

The question is often asked what makes a dynamite sensitive. Instead of answering this question, let us consider how a dynamite can be made less sensitive. When nitro-glycerine—a heavy liquid—was first discovered it was used as such and it was soon found that it was far too sensitive. Nobel incorporated kieselguhr, or infusorial earth, with nitro-glycerine and called this compound "dynamite." The modern dynamite contains an active absorbent, one that enters into the combustion of the explosive, and is ever so much more powerful than a kieselguhr-dynamite with the same percentage of nitro-glycerine. It is superior in every respect but one, and that is, it does not hold the nitro-glycerine as firmly as the infusorial earth did.

What is it then that renders a nitro-glycerine compound permanently less sensitive? Here again we have two causes: First, anything that dissolves in, remains with, and dilutes the ultimate particles of nitro-glycerine. When once in solution and with the proper solvent there cannot be any stratification. This insures less friction between the ultimate particles of nitro-glycerine and then, again, these particles will be hampered in their effort to vibrate synchronously in response to a detonating wave. Second, anything that will dissolve in, become a part of, and hold rigid the ultimate particles of nitro-glycerine, preventing friction and hampering vibration, will render the nitro-glycerine less sensitive. This is accomplished by collodion cotton dissolving in nitro-glycerine and converting the same into blasting gelatine or, with "dope" into gelatine-dynamite.

Dynamites are not the same, neither as to chemical composition nor as to physical condition, and the latter is largely influenced by atmospheric conditions—temperature and barometric pressure. All explosive phenomena must be referred finally to an elevation of a particle of nitro-glycerine to the explosive point. This may be occasioned by a sharp blow or fracture of a frozen crystal of nitro-glycerine or the gradual storage of heat generated by some slow process of oxidation akin to spontaneous combustion. The "dope" materials are in general bad conductors of heat.—*Harry East Miller in Mining Press.*

AIR LIFT INFORMATION

BY C. M. WETHERILL.

While it is conceded that the air lift is not as economical as other systems for general pumping, under certain conditions it has proven economical and satisfactory; especially where the water is taken from a well that is less than 12 ins. in diameter and the pumping level of the water does not exceed 225 ft. above the lowest water level in the well. The advantage of the system is that the machinery is all above ground. There is nothing in the well to get out of order and so call for "pulling the well," which so often occurs with the plunger type of pump. The efficiency of the air lift after years of service remains the same, while wear of plunger pumps often causes a drop in efficiency of from 40 to 50

per cent. particularly if the water contains fine sand.

The air lift system has its principal use when the quantity of water is the chief concern, and where it is to be taken from small wells widely separated, and where the cost of operation is not a large consideration. It is the best system of pumping for taking a large amount of water from the small well.

The air lift is a desirable system in small towns securing their supply from deep wells of small bore, especially when electric power is used. The system may be installed to operate automatically, and the plant may be taken care of by the town marshal. In water works of this class the water is brought to the surface reservoir with air. Then it is taken up by a triplex or centrifugal pump, operated by an electric motor, and elevated to the gravity tank. Both of these machines can be operated by automatic float switches.

SUBMERGENCE.

In piping a well it is important to have the proper amount of submergence. This should be between 50 and 65 per cent. of the total length of the eduction pipe; about 60 per cent. seems to give the best results in general. This submergence regulates the necessary running air pressure.

Let us suppose the well is 400 ft. in depth. It is assumed that when pumping the quantity of water wanted the water level in the well will drop 75 ft. below the surface of the ground. The elevation above the surface of the ground is 25 ft., making the total lift above the water level in the well when pumping to the point of discharge a total of 100 ft. Assuming that the submergence should represent 60 per cent. of the entire length of the water discharge pipe, this lift represents 40 per cent. Multiplying this total lift of 100 ft. by 1½ gives 150 ft., which is the 60 per cent. submergence required. Adding the 150 ft. submergence to the 100 ft. lift gives the total length of 250 ft. of water discharge pipe.

EXTREME LIFT PRACTICABLE.

It must be borne in mind that the limit of practical utility to which the water can be raised by this system is 225 ft. above the lowest water level in the well. This covers the majority of cases, although under especially favorable conditions water has been raised as high as 260 ft. above the level ot the well. It is not safe, however, to count on a higher lift than 225 ft. except under very favorable conditions.

"SLIP" AND HORIZONTAL PUMPING.

The principle on which the air lift works is that the mixture of air and water in the discharge pipe is lighter per unit volume than the same volume of water outside the eduction pipe. Therefore the mixture in the eduction pipe will be forced to a much higher elevation than the depth of submergence. In the upward motion of the mixture, or alternate pistons of air and water, in the eduction pipe the air has a tendency, on account of its lighter weight, to come to the surface faster than the water. This causes what is known as "slip," and is one of the principal reasons for the low efficiency of the air lift.

The air lift system is not adapted to pumping horizontally a great distance, and for this reason the horizontal discharge should always be kept as short as possible. When the reservoir is some distance from the wells it is better to discharge into a small elevated tank and then allow the water to flow to the reservoir by gravity.

RATIO OF AIR TO WATER VOLUME.

When 60 per cent. of the entire length of the water discharge pipe is submerged the following ratio of air to water should be observed:

For lifts not exceeding	Volumes of air to 1 of water.
25 ft.	2
50 ft.	3
75 ft.	4½
100 ft.	6
125 ft.	7½
150 ft.	9
175 ft.	10½
200 ft.	12

Thus to ascertain the volume of air required, quantity of water and lift being known. Divide the required quantity of water in gallons by 7½ in order to reduce it to cubic feet; then multiply the quotient by the figure from above tabulation, representing the volume of air required for the lift necessary to raise the water. Assume, for instance, that 200 gals. of water are to be raised to the surface in a minute and that the water level will fall 75 ft. below the surface when pumping. $200 \div 7\frac{1}{2} = 26.5 \times 4\frac{1}{2} = 120$ cu. ft. of free air required per minute.

REQUIRED AIR PRESSURE.

The required air pressure is determined by the head of water outside of the water discharge pipe from the level in the well to the bottom of the water and air pipes. Assume, for instance, that the water level in the well stands even with the surface of the ground when not pumping, but that when it is pumped the water level will drop 50 ft. below the surface of the ground. This would make it necessary to have the air and water discharge pipes 125 ft. long. When starting pumping it would, of course, be necessary to raise a column of water 125 ft. in height, and allowing 0.434 pressure for each foot lift the starting air pressure required would be $125 \times 0.434 = 54$ lbs. As it has been assumed that the water level will drop 50 ft. after the well is pumped, there would then be a head of water outside of the water discharge pipe 75 ft. in height with which the air would have to contend, making the running air pressure $75 \times 0.434 = 32.5$ lbs.

Still an easier method of obtaining the volumes of free air, pressure, submergence and indicated horsepower is given in Table I. For instance, say it is desired to raise 210 gals. of water per minute 50 ft. high. This will require 75 ft. submergence, 33 lbs. air pressure, 84 cu. ft. of free air per minute and the compressor must develop 7.5 I. H. P.

TABLE I.—RELATIVE LIFT, SUBMERGENCE, AIR VOLUME AND PRESSURE, AND I. H. P. OF COMPRESSOR.

Lift, ft.	Submergence required, ft.	Air pressure, lbs.	Cu. ft. free air per gal. per minute.	I. H. P. per gal. raised per min.
25	38	17	0.3	.0156
50	75	33	0.4	.036
75	113	49	0.6	.07
100	150	65	0.8	.0925
125	188	82	1.0	.16
150	225	98	1.2	.212
176	263	115	1.4	.265
200	300	130	1.6	.318

Under favorable conditions the air consumption in Table I may be reduced as much as 15 or 20 per cent.

Efficiencies as high as 33 per cent. have been obtained under favorable conditions when a fair-sized, first-class, two-stage compressor is used. This is the I. H. P. or the electric power at switchboard figured against the theoretical horsepower of water delivered.

Table II gives a list of the approximate size and capacity of side inlet devices for foot pieces now placed on the market by several companies and the size of wells they will go into.

TABLE II.—DATA ON SIDE INLET DEVICES.

Air pipe, ins.	Water pipe, ins.	Size well, ins.	Maximum capacity, gals. per min.
¾	1½	4	25
1	2	4½	50
1	2½	5	75
1¼	3	6	105
1½	3½	7	145
1½	4	8	190
2	6	10	425
2	5	9	300

Sometimes the size of the well does not permit the use of the side inlet piece; then the central air pipe system is used. If the well is cased far enough down to admit of 80 per cent. submergence, the well casing is used as the water discharge pipe and the air pipe is put down into it. About 2 ft. from the bottom of the air pipe a number of holes are drilled for the air to escape from. The size of the pipe depends a great deal upon the size of the well and the quantity required, but the following figures will give a general idea:

Well casing, ins.	Use air pipe, ins.	Capacity gals. per min.
3½	1¼	115
4	1½	150
5	2	240
6	2	360

In estimating the quantity of water that can be forced through a given size discharge with the best economy, the following rules should be observed:

25 ft. lifts 10 to 11 gals. to each square inch area of water pipe.

50 ft. lifts 12 to 13 gals. to each square inch area of water pipe.

All higher lifts 14 to 15 gals. to each square inch area of water pipe.

Usually this can be exceeded, but only at the expense of economy in air consumption. In pumping wells of 12 ins. or more in diameter, unless the well is crooked, the air lift does not give as good results as the deep well centrifugal pump that is now being placed on the market by several companies.

The data here given have been gathered during the past ten years by the author both from experience and observation. Some of the information has been obtained from water works superintendents and sales engineers who have had the opportunity of testing and

watching the operations of this system of pumping. For general use the above figures have proven very satisfactory.

It is well to bear in mind, as pointed out in *Engineering and Contracting* of March 17, 1915, that the air lift should not be installed without the advice of an engineer who has made a special study of the subject, and only after he has been given an opportunity to make trials with various lengths of air pipe and various speeds of compressor operation after the lift has been installed. The latter consideration is important, as by successive adjustments of submergence and compressor speeds the most economical operating conditions may be found.—*Engineering and Contracting.*

HOW COMPRESSED AIR SAVED THE FLORISTON

BY ROBERT G. SKERRETT.

Shortly after the beginning of the war in Europe, the steamship *Floriston* sailed from Quebec under rush orders bound for England with a cargo of hulled grain. Officially, the ship has a gross tonnage of 3,429 tons and a net tonnage of 2,236 tons. However, owing to the exigencies of the hour, she was actually loaded with 4,000 tons of wheat, which put her down considerably deeper than her Plimsoll mark.

Just before clearing the Straits of Belle Isle on a dark night the ship hit an iceberg squarely bow-on when running at a speed of about 10 knots. She was so badly injured that her skipper ran her ashore upon the nearest point of the coast of Newfoundland. There for several days she pounded upon the rocky bottom and materially aggravated the damage forward. A small steamer, the *Wren,* came to the rescue of the *Floriston* and managed to pull her off and to tow her into Port Saunders—the nearest haven. The *Floriston* came to anchor in 13 fathoms of water, and at the time was drawing 31 feet forward and 22 feet 4 inches aft. After practically abandoning all hope of saving her, recourse was had to compressed air under the supervision of Mr. W. W. Wotherspoon of New York city, and the damaged craft was safely run under her own power some hundreds of miles to Quebec.

It was not until the *Floriston* reached Port Saunders that it was possible to examine her injuries. After the divers had made two surveys, it was found that the vessel's bow had been very badly crumpled up. The accompanying illustrations clearly indicate the extent. The upper and the lower forepeak were flooded, and so, too, were cargo space No. 1 and Nos. 1 and 2 ballast tanks, while ballast tank No. 3 was leaking, but could be kept under control by the ship's pumps.

The Canadian Salvage Company and the Quebec Wrecking Company took the ship in hand and started at once to make her ready for the application of compressed air—first removing about 800 tons of grain from the forward hold, where fermentation had started and the gasing was very noticeable. Immediately after the installation of the necessary air compressors, ballast tanks Nos. 1 and 2, and so much of the lower forepeak above the ruptured skin were placed under pressure and "blown," together with the upper forepeak, and in this way the vessel's bow was raised 4 feet, bringing her to the 26-foot waterline.

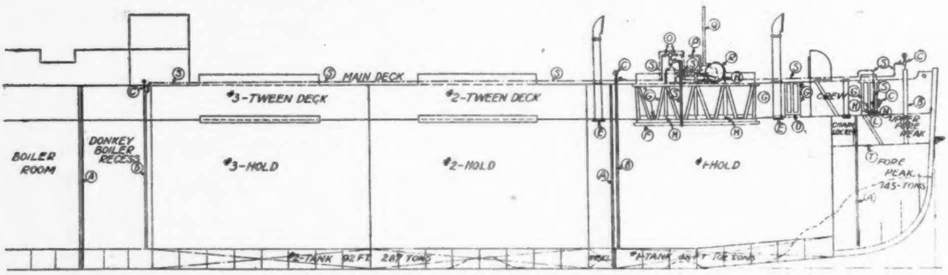
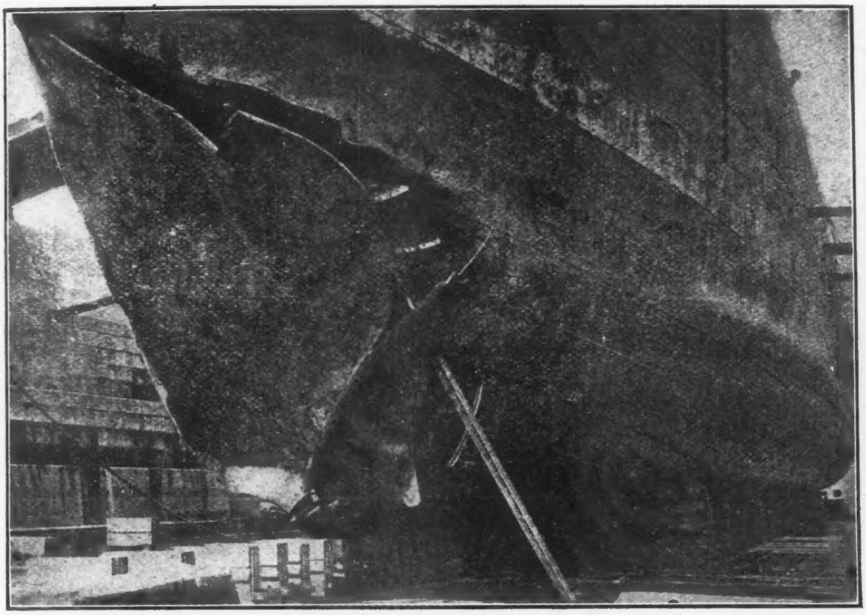


Fig. 1—*A*, Sounding Pipes Closed to Compartments Placed Under Pressure. *B*, Air Escapes Used for Connecting Pressure Sets to Compartments Placed Under Pressure. *C*, Pressure Sets. *D*, Closing Cover for Trimming Hatch. *E*, Closing Covers for Ventilators. *F*, Closing Hatch for No. 1 Hold. *G*, Shoring and Bracing for Hatch Covers. *H*, Strong-backs Bolted to Ship's Structure. *J*, Closing Covers for Hawse Pipes. *K*, Closing Hatch for Air-lock. *L*, Underhung Escape Hatch for Air-lock. *N*, Blow-off. *O*, Control Valves for Air Supply to Compartments. *P*, Steam Supply to Compressor. *Q*, Exhaust from Compressor. *R*, Air Compressor. *S*, Air Supply Pipes to Compartments *T*, Manhole Access Forepeak



FLORISTON IN DRYDOCK.

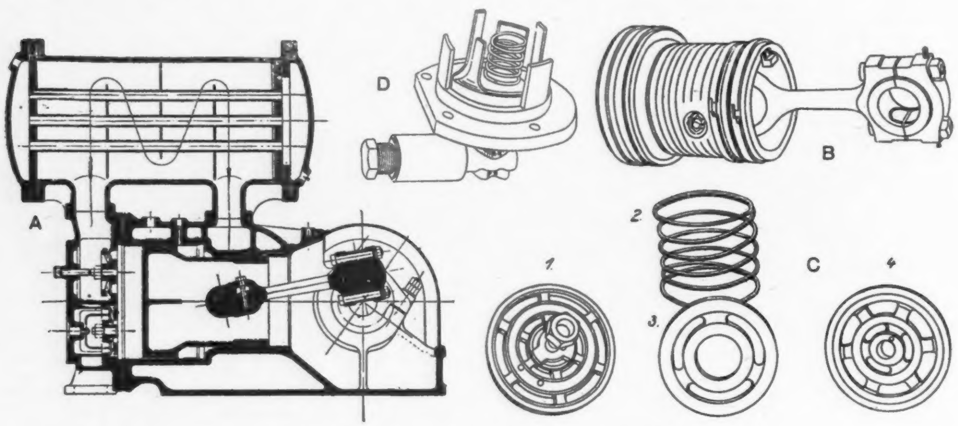
In making the air connections, the existing air vents were used in the drained compartments for conduits, while certain other air vents were sealed. In this manner complete control of the various spaces was secured from a single operating station on the main deck. In accordance with the Wotherspoon system the flanking compartments or neighboring spaces were also put under pressure, in order to reduce the stresses upon the divisional bulkheads and the overlying decks. The large hatch leading into cargo space No. 1 was sealed by an airtight cover composed of two layers of planking with intervening sheets of tar paper. The hatch leading into the upper forepeak was similarly sealed, with the addition of an air-lock attachment by which admission into the forepeak could be secured when that space and the compartment below were under pressure. In order to support the deck immediately above the forepeak and the cargo space, shores were placed between it and the main deck just above. This was a very necessary provision, because the *Floriston* was inclined to "hump" as she forged ahead on her long trip to Quebec, and the intermittent stresses would probably have proved fatal but for the stiffening secured by binding the two decks together in this fashion.

The entire work of preparing the *Floriston* for her run from Port Saunders to Quebec was finished in the quick time of six days, thanks to the experience previously gained in handling some other vessels in the same manner, although not so far away from bases of repair. The nature of the steamer's cargo demanded rapid action, and compressed air was the very best medium with which to battle with the gases given off by fermentation while furnishing the needful support to the confining bulkheads and deck plating. The salvers were obliged to watch this subtle foe at every stage of the homeward journey and to adjust the air pressure in the surrounding compartments accordingly.

The accompanying diagram shows the manner in which the salvage installation was made, and it is doubtful that the vessel could have been saved by any other method, considering the cargo aboard and her remoteness from any place for repairs. It was quite out of the question to use cement on the job, and compressed air was logically the only rational solution under the circumstances. The gravity of the *Floriston's* wounds are quite manifest, but because her stem and forefoot were turned so far back and upward, the first diver reported rather moderate injuries—assuming merely the rupture of the bottom plating and

judging the upturned stem to be the lower edge of the break. This long trip to a repair port emphasizes the potential advantages of a permanent compressed air self-salving installation aboard large ocean-going vessels. The initial cost is moderate, and ships so equipped would unquestionably be able to obtain better insurance rates and shippers and owners feel just that much more secure.—*International Marine Engineering.*

President Wilson has ordered the name of Culebra Cut to be changed to Gaillard Cut. This was done in honor of the late Colonel Gaillard who had charge of this most difficult part of the canal work.



A SINGLE CYLINDER TWO-STAGE COMPRESSOR.

A SINGLE CYLINDER, TWO-STAGE, CRANK DRIVEN AIR COMPRESSOR

The cut here reproduced from the Journal of the American Society of Mechanical Engineers, shows the essential features of a new compressor built in Bavaria, Germany. Although a two-stage, single cylinder is not a novelty in itself, special claims as to compactness and rigid stability may be made for the present design.

The base of the machine rests on a prepared foundation for its entire length which is effective in eliminating vibration. The low pressure cylinder hood is also a valve chamber, containing both the inlet and the discharge valves for that end. After the preliminary compression the air passes through a large intercooler and then into the annular space where the second compression takes place. At C is shown the type of valve used, a ring valve with small lift.

As the compressor is assumed to be belt driven the intake of air is regulated by a separate unloading device D which is automatically regulated by the receiver pressure. In addition to this, further regulation is secured by an electromagnetic clutch by which the crank shaft is stopped or started while the wheel continues to run.

WHAT IS ATMOSPHERIC HUMIDITY?

BY G. P. PEARCE.

While talking at an Engineer's Club, the conversation happened to turn on the subject of humidity. The majority were of the opinion that it was moisture absorbed by the air, something like a sponge absorbing water; some thought it was an actual chemical combination that took place between the air and water, as oxygen and carbon combine to form carbonic acid gas, and one was strongly of the opinion that it simply was minutely divided or atomized water mechanically suspended in the air. Not one of them knew just how to figure out the weight of a cubic foot of saturated air at a given temperature, or the weight of the contained moisture.

There is nothing mysterious about humidity except, perhaps, its name, which is derived from a Latin word meaning "to be moist." Humidity is simply a way of talking about a mixture of air and steam. Let us take a tank that holds just one cubic foot and pump out all the air. We will also assume that the temperature of the engine room where we will

make this experiment is 90 deg. F., which will be the temperature of the tank. Now let us inject a little water into the tank, and of course we all know what will happen; enough of it quickly evaporates into steam until the space becomes saturated for the temperature of 90 deg. F. We will next draw out all the surplus water and now have a cubic foot of saturated steam at a temperature of 90 deg. F., and if we had carefully weighed the tank before and after, on very sensitive scales, we could discover the weight of the cubic foot of steam. But there is no need for us to go to all this trouble, as we can find it all from the steam tables in our engineer's handbooks; by looking up the new Marks & Davis steam tables, we find for a temperature of 90.1 deg. F., which is near enough for this experiment, that a cubic foot of steam at this temperature, weighs 0.002,137 lb., and that the pressure is 0.698 lb. per sq. in. absolute. So now we know all we want about a cubic foot of steam under these conditions.

We will next pump out this stream and then let the tank fill with dry air, which we can get by letting the air suck in through some calcium chloride; this will completely dry it. We now have a cubic foot of dry air at 90 deg. F., which will weigh 0.072,197 lb., as we can find from a table of air weights; or we could get it by very accurately weighing the tank. The pressure we will take as 14.7 lb. per sq. in.

Now, it is known that the space above a liquid will always become saturated with its vapor until a balance is established, whether the space at the beginning is a vacuum, or is filled with a gas; in other words, the presence of gas has no effect upon the amount of vapor formed. Take water, for instance; the weight and pressure of the vapor for saturated steam formed over the surface of the water will build up to the same amount whether there is any air present or not. It seems as if there is plenty of room for the steam molecules to be present in the air without in any way interfering with one another. Let us then take our tank containing one cubic foot of air and inject some water into it. This will evaporate according to the abovementioned law until the tank is filled with steam to the same weight and pressure as found when it was tested.

Starting from the vacuum this is 0.002,137 lb. at 0.698 lb. per sq. in. Taking out the unevaporated water we now have a cubic foot space with 0.002,137 lb. of steam and 0.072,197 lb. of air, a total weight of 0.074,334 lb., and the pressure inside will be 14.7 lb. absolute, due to the air and 0.698 lb. due to the steam, a total pressure of 15.398 lb. per sq. in. Next, we will open the valve and let enough of the mixture escape to reduce the pressure to atmospheric, or 14.7 lb. per sq. in. This we can easily figure, for it will be according to Boyle's law—

$$P_1V_1=P_2V_2$$

Thus 15.398 lb. multiplied by 1 equals $14.7\times X$,

or $X=1\times 15.398\div 14.7=1.0475$ cu. ft.

and the weight of one cubic foot will be equal to

$$0.074{,}334\div 1.0475=0.070{,}95 \text{ lb.},$$

which is the weight of one cubic foot of saturated air (100 per cent. humidity) at 90 deg. F.

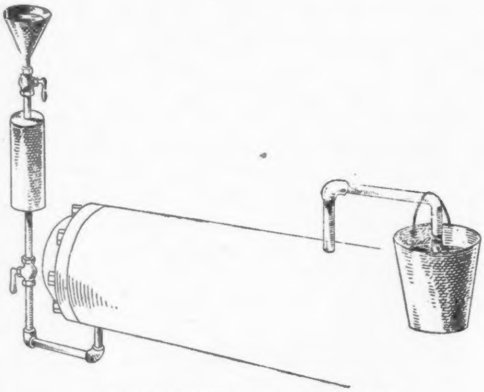
We will now find the weight of water in the cubic foot of saturated air, which is easy, because we know that the original cubic foot of steam weighs 0.002,137 lb., and that, due to its pressure combining with that of the air, it expanded to 1.0475 cu. ft. Therefore the weight of the water, or rather steam, in the cubic foot of saturated air is $0.002{,}137\div 1.0475=0.002{,}041$ lb., and the weight of the air of course is $0.070{,}95-0.002{,}041=0.068{,}909$ lb.—*Practical Engineer.*

PNEUMATIC TOOLS BOOST THE MONUMENT BUSINESS

The change that has come about in the monument business is tremendous. Many years ago when we first adopted our compressor plants for the retail monument dealer you would not find more than perhaps one man out of twenty-five that had any kind of equipment at all. This party would perhaps have a large shop where marble was cut out of rough and sometimes the plants were as big as 50 to 100 H. P. and employed from thirty to forty men. With the advent of pneumatic tools, making it possible to cut granite, we found a very quick change coming over the monument business. The old style shops gradually were pushed aside and we had quite a demand for power plants from 15 to 40 H. P. With the low price gasoline, and the ease of adapting them to the monument man's conditions we installed many of these outfits.

About seven years ago we had occasion to build several small plants for cemetery lettering. These outfits consisted of a plain 2 to 3 H. P. gasoline engine connected by means of belt to a small compressor and the entire outfit mounted on truck. These were made at the special request of some of the more progressive monument dealers. After putting out a few of these machines we noted that our customers were in the habit of using these machines for shop work, sometimes while their big plant was shut down for repairs or during the slack season. We suddenly realized that there would be a permanent demand for these smaller outfits and not only could these plants be used for cemetery work but it would be possible to have every retail monument dealer, no matter how small his shop might be, equipped with such a machine. Of course, there has always been a certain amount of prejudice to be overcome because we used gasoline on these early equipments. This fact forced us to make electric driven units as well. Though an electric outfit costs from three to five times as much to operate still they are entirely fool-proof. Where they are to be used for the shop only they have been successful. Of course, they cannot be used for cemetery work. Neither can they be used in districts where day current cannot be obtained.

Not only has this small pneumatic tool plant made it possible for the small dealers to compete in the character of their work with the better equipped larger shops but they have been able to get down in price, turn their work out quicker and in accordance with their promises. They have been able to get stock monuments during the dull season instead of trying to live twelve months off of the earnings of six months. At the same time the mere hum of pneumatic tools brought business to the doors of our customers. The mere fact that a man has a good set of tools to work with seems to fire him with a certain amount of ambition. He takes more pride in his work, he does things more thoroughly, it wakes him up to the possibilites that are floating all around him. We prophesy that the time is coming when a dealer in the monument business will either have to have some good, clean-cut way of getting his work out quicker and better, or he will be forced to quit the business.—*Henry N. Schamm, in Granite, Marble and Bronze.*



ARRANGEMENT FOR ACID WASH.

ACID CLEARS A WATER JACKET

The cooling water for the air cylinder jackets of a compressor 18¼ and 12¼ × 12 in., the water containing a large amount of sulphate of lime, had been throttled and made to flow so slowly that the water was abnormally heated so that it deposited inside the jacket a hard scale that we could not get at to remove with tools. I used muriatic acid piped to flow through the jacket as shown in the crude sketch herewith. To operate, close the lower valve and fill the reservoir with acid. The reservoir should be placed higher than shown to give a little head or pressure. Then open the valve and the acid will fill the jacket and overflow into the pail. It took ten gallons at 60 cents per gallon to do the job, using it over and over again as long as it had any strength. It worked fine, disintegrating the scale and clearing the jacket.—*W. A. Hendry, in Power.*

THE WESTINGHOUSE AUTOMATIC AIR BRAKE

BY HERBERT T. WADE.*

In the year 1890, with a train weight of 280 tons running at a speed of 60 miles per hour, the energy to be dissipated was about 33,000 foot-tons and the stopping distance with the application of the brakes was 1,000 feet. In the year 1913, with a train weight of 920 tons, running at this speed of 60 miles per hour, the energy dissipated was 111,000 foot-tons, almost four times greater than that of the train first mentioned. Now, if the second train was equipped with a brake of the same class as that of the former, the stopping distance would be 1,760 feet and its collision en-

*Abstract from Scientific American.

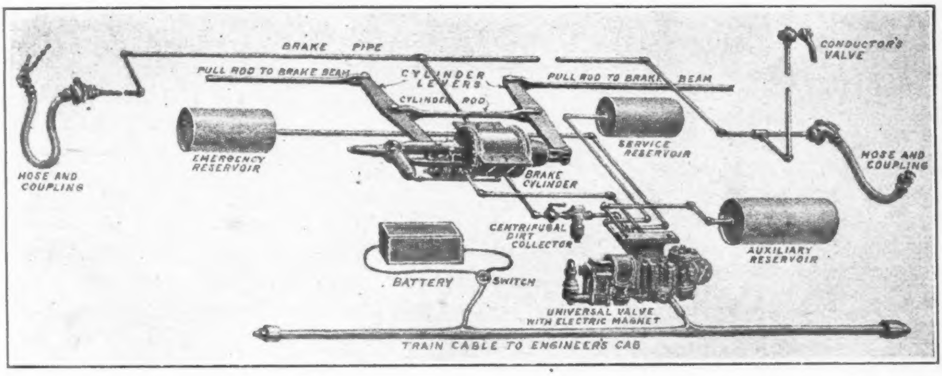
ergy when it passed the 1,000-foot mark where the first train would have stopped would still be 48,000 foot-tons, or one and one-half times as much as the 1890 train had when the brake was applied, with still 760 feet to run. With the latest improvement in the air brake such a train can now be equipped with the new brake apparatus so that it can be stopped in 860 feet, at which point with the old brake it would have been running at 43 miles per hour and with a collision energy of 57,000 foot-tons, or still about twice that contained in the train of 1890 at the beginning of the stop. In fact, the energy that must be dissipated by the air brake on a modern train with modern speeds of travel has increased eighty-fold since the original invention of the air brake.

The important advantages that now figure in the Pennsylvania equipment were secured by improvements both in the effectiveness of the brake as a whole, as well as in detail. By the brake is meant not only the triple valve fundamental to the Westinghouse air brake, but the entire mechanical organization and assembly of the various elements. Improvements were made in the efficiency of the braking system as a whole, and also in the automatic and manual control of the brake operated, this function, naturally, being rendered more difficult by the increasing lengths of trains. But before any such innovation could be made on a large scale it was necessary that it should receive a complete and thorough test under actual working conditions. This was done on the Pennsylvania Railroad, employing a train air brake many elements successively have of twelve steel passenger cars and a modern locomotive, weighing nearly 1,000 tons and about 1,000 feet in length.

The locomotive and cars are fitted with the new mechanism, which, in its most improved form, aside from the principle of operation concerned, involved also the use of two shoes per wheel as higher retarding forces could be developed than were possible with a shoe on only one side of the wheel, on account of the limits of excessive piston travel, of brake shoe wear and distortion producing variable results of unequalized strains in brake, and of journal troubles.

In the improvement and perfection of the been added until to-day the mechanism, while increasingly effective, is of considerable complexity. For example, with long trains with the older systems there would be delay in the application of brakes at the rear, and there would be unevenness and shock in stopping. Due to the delay incident in the mechanical operation of the system the stopping distance at high speeds and with heavy loads and long trains could not hitherto be reduced as was desired in the interest of safe and effective operation. The new system secures immediate action at each triple valve by substituting therefor a universal control valve, where not only are all the essential features of the air control included, but also there is incorporated an electric system whereby the braking mechanism at the rear end of a long train, or at any car, in fact, does not have to wait an appreciable amount of time for the difference in pressure to be realized, but the valves are opened or closed by local electro-magnets energized from a battery circuit in each car.

The electro-pneumatic equipment is ar-



LAYOUT OF AUTOMATIC AIR BRAKE.

ranged so that when operated eletcrically the service application of the brakes is actuated by a reduction in brake pipe pressure as when operated pneumatically. The electric effect is the same as the pneumatic effect and the electric valves operate the pneumatic valves in similar fashion, only the response is made immediately—the electro-magnetic valves responding more promptly. The release magnets are controlled by the brake valve handle in either release or holding position, and with an electro-pneumatic emergency application the emergency magnets on all cars simultaneously and instantaneously energize and open their respective emergency magnet valves, which, in turn, cause the quick action parts of each universal valve to operate and produce an emergency application of the brakes. If the hose bursts or a conductor's valve, familiarly seen in a passenger car, is opened, the first universal valve to be affected by the resulting drop in brake pipe pressure will operate pneumatically and close its emergency switch so that the emergency magnet circuit throughout the train is energized and an electric emergency application on all brakes obtained.

The new system, which at first examination is quite complicated, both by its arrangement of electric connections and the arrangement of valves and magnets, secures now the application of the air brakes more quickly, also giving increased emergency stopping power, and enables the use of a higher pressure which may be held without diminution toward the end of a stop, while at the same time a more efficient design and better installation of foundation brake rigging has been adopted so that both the application and release of the brakes is more positive and reliable in all its operations. The new system, as stated, employs two shoes per wheel, which is known as the "clasp brake," and it is arranged to operate so that the time of obtaining the maximum emergency brake cylinder pressure on the train as a whole, according to the official tests, was shortened from eight seconds with the best previous equipment to 3.3 seconds with the improved apparatus; and when the electric control, which was a further feature of the new system, was used, this could be diminished to 2.25 seconds. The electric system is controlled from the engineer's valve without extra levers or switches, the electrical mechanism being connected with the simple control valve, the circuits being arranged within. The system also works automatically in case of any failure along the line, and there results a simultaneous application of just as great retarding force with the elimination of all violent slack action and shock.

With the universal control a train of twelve steel cars and locomotive with the electro-pneumatic brake, 150 per cent. braking power, clasp brake rigging, unflanged brake shoes, can be stopped:

From 30 miles per hour in200 feet equivalent to an average retarding force of 300 pounds per ton.

From 60 miles per hour in 1,000 feet equivalent to an average retarding force of 240 pounds per ton.

From 80 miles per hour in 2,000 feet equivalent to an average retarding force of 214 pounds per ton.

It would seem, therefore, that here we have an important step forward toward increase of safety, and that increased speeds may be used with proper safety, while greater density of traffic can be permitted under good conditions of operating that will give increased returns.

AIR-LIFT NOMENCLATURE

Standard terms used in air-lift pumping are as follows: (1) Static head: normal water-level when not pumping, measured from surface or top of well casing. (2) Drop: point to which the water-level drops below the static head while being pumped. (3) Pumping head: level of water when pumping as compared to ground surface or top of well-casing. Static head + drop = pumping head. (4) Elevation: point above the ground surface or top of well-casing to which water is raised. (5) Total lift: distance water is elevated, from level when pumping, to point of discharge, at an elevation, and includes: elevation + static head + drop = total lift. (6) Lift: distance the water is elevated from level when pumping to point of discharge at surface, and includes: static head + drop = lift (or pumping head). (7) Submergence: distance below the pumping head at which the air is discharged into the water. (8) 100 per cent.: the vertical distance the air travels with the water from point introduced to point discharged, and includes: total lift or lift + submergence = 100 per cent. (9) Starting submergence: distance below static head at which the air picks up the water.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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CONTENTS

THE EXPLOSIVE AGE

Why should not the present be called the age of explosives, or, perhaps still better, the explosive age? There would seem to be no other characterization so applicable. The present world wide war, for instance, which is the all engrossing fact of the time, came upon us with the suddenness and the destructive force of a terrific explosion, and in the successive war operations in detail explosives are all in all. There is practically no more face to face cutting and thrusting. The sword is obsolete, even the bayonet is obsolescent, and the spectacular battle-axe is forgotten, so that when the time shall come for the war to cease it is not easy to see how the swords and the spears shall be turned into plowshares and pruning hooks, since the ancient weapons of war are now conspicuous by their absence from the bloody field, and it would be absurd to try to continue their vogue.

It is a war of projectiles, and not satisfied with the initial explosion by which the projectile is sent on its long flight for destruction, it is now normal practice to have a supplementary explosion after the shot is thrown, and so all the contestants are crying for shrapnel. Then, too, the horse for the transportation of munitions and supplies is superseded by the explosive driven motor wagon, and explosives, too, are the one essential element of the Zeppelin, the aeroplane and the submarine. How suddenly modern wars would end if explosives ceased to explode.

However, there is nothing essentially devilish in explosives as such. They are quite as ready to work, and will work quite as efficiently in the interests of peace as of war. Not only are the dynamites and explosives of the fiercer type our most efficient agents in the mining of our mineral wealth, but what we may call the milder explosives are coming to be our most economical sources of power in all the industries.

Soon will be coming along the season of county and state agricultural fairs; and in the exhibits there to be seen, nothing perhaps is more striking than the completeness with which the explosive engine, the gasoline motor, has superseded the steam engine. The Humphrey pump and the Deisel engine are beginning to show the applicability of the explosive motor to the largest power units, and

the latter is directly indebted to Compressed Air for its success.

HEATING VALUE OF COMPRESSOR JACKET WATER

Can a mixture of air and water be compressed in a cylinder so the heat of compression will convert the water into steam, the water entering the cylinder in the form of spray or vapor and at a temperature of 200 deg., the air being at the same temperature? If this can be done, what are the conditions necessary to bring about this operation?

D. F.

A. Although in the act of compression the temperature of air rises high, the actual heat units represented are very few and would have no practical vaporizing effect upon even small quantities of water. Water jacketing is necessary for air compressor cylinders to keep their temperature down; but it is surprising to note how slowly the water is warmed—it would be scarcely proper to say heated. At the high speeds at which compressors are now ordinarily run, compressing by single-stage up to say 60 lb., or by 2-stage to 100 lb., the temperature of the jacket water, when flowing quite leisurely through, hardly rises above blood heat.

It is a curious fact that a proposition just the reverse of this has been a standing challenge to engineers for more than half a century. The "Cloud" engine, and many other contrivances, have proposed to get a cheap accession of power by injecting a considerable charge of air into a steam cylinder at each stroke and then letting the heat of the steam increase the volume and the power value of the air. Something may be said for this as to its theoretical feasibility, but nothing of practical and permanent value has ever developed from it.—*Frank Richards in Practical Engineer.*

NEW BOOKS

The Model T Ford Car, its Construction, Operation and Repairs. By Victor W. Page, Norman W. Henley Publishing Company, New York. 288 pages, 7½ by 5 inches, nearly 100 illustrations. Price, $1.

When it is understood that there are considerably more than half a million Ford cars in service, the field of usefulness for such a book as this must be immense. It is written by an expert and treats the subject in a thorough and exhaustive way. Much of the information and instruction embodied should be course be serviceable to operators of other machines, although no such claim is made.

Measurement of Gases where Density Changes, compiled by Henry P. Westcott, Metric Metal Works, Erie, Pa. 60 pages, 7¾ by 3¾ inches. Price, 50 cents.

The book consists entirely (after a preliminary explanation) of tables of multipliers to be used in connection with meter readings of the flow of natural gas at different pressures. There are twelve tables covering pressures ranging from a vacuum of 25 inches of mercury to 3 lb. above atmosphere.

AUTOMATIC AIR-PILLOW INSTRUCTION

The bathing beach proved attractive to the children and while they possessed the ambition to learn to swim they were also possessed by a fear of the water. The knowledge that the human body is not much, if any, heavier than water when the lungs are normally inflated with air did not seem to inspire sufficient confidence to lead them to make the plunge. Finally an air pillow was procured, properly inflated and adjusted to one of the girls, and with the confidence thus inspired a successful effort was made at swimming. Unbeknown to the swimmer a pin hole was made in the air pillow and the air soon escaped but confidence took the place of the air. The weight of imaginary fear was being carried by an imaginary air pillow and utterly unconscious of the true situation that girl was experiencing the thrills of a new sensation and when her attention was called to the fact that there was no longer any air in the pillow it did not take her long to make up her mind that she could swim without its aid. We all need air pillows at times in our lives to help us over unknown paths and the community needs air pillows to help it solve the road problems confronting it.—*From a speech by I. B. Clarkson, as reported in The Road Maker.*

The United States is now producing more than two-thirds of the world's petroleum, and there is a likelihood that the proportion will be increased. The country's oil production is valued at one-third that of all the metals mined.

ECONOMY OF COLD INTAKE AIR FOR COMPRESSORS

BY R. S. BAYARD.

It has often been observed that the output of an air compressor is greater in winter than in summer; that is, it seems that a machine which has had to "hustle" to furnish air in summer, may be able to maintain the required pressure at a reduced speed during the winter. The reason for this is often asked, so an explanation will be of interest.

This difference can be observed only when the compressor takes its air through a duct leading from the outside air, because it is due to the effect of the difference of air temperature between the compressor intake and the place where the air is used or conveyed through.

Imagine a cylinder having a perfectly tight piston held, we will say at midstroke, and the half-cylinder full of air at atmospheric pressure and at a temperature of 60 deg. F. The atmospheric pressure is, with 30-in. barometer, 100 deg. F. This 14.7 lb. per sq. in. With the piston held rigidly and leak-tight, assume that we can heat the cylinder so that the air inside will become 100 deg. F. This will cause the air to expand and try to occupy more space, but if the piston will not move the air cannot expand, so it will increase in pressure. Mathematically, the pressure produced in this way will be

$$14.7 \times \frac{100 + 460}{60 + 460} = 14.7 \times \frac{560}{520} = 15.84\ lb.$$

That is, the new pressure, absolute, will be equal to the first pressure, absolute, multiplied by the ratio of the absolute temperatures. (The absolute temperature is found by adding 460 to the Fahrenheit temperature, as done above).

If in the cylinder we are considering, the piston is allowed to move as the air expands, and if it has no friction, so that the air pressure does not increase, the final volume will be larger than the original volume in the ratio of the absolute temperatures. If the original volume was, say 10 cu. ft., the final volume after the piston has moved due to the increase of air temperature will be:

$$10 \times \frac{100 + 460}{60 + 460} = 10 \times \frac{560}{520} = 10.77$$

At the usual room temperature (about 60 deg., or 520 absolute) the increase of volume is, roughly, 1 per cent. for every 5 deg. F. increase of temperature.

Let us see how the foregoing applies to a compressor plant. Irrespective of the outside temperature, the air in the shop pipe lines will be nearly at the temperature of the room by the time it reaches the tool. Suppose that in winter this temperature averages 68 deg. F., and that the air finally reaches the tool at this temperature. If the compressor takes in 1,000 cu. ft. of free air (air at atmospheric temperature and pressure) directly from the room, it will also deliver 1,000 cu. ft. of free air at the tool, because the final temperature is the same as that at which it entered the compressor.

In summer the same conditions apply as long as the compressor takes its air from the same room in which the compressed air is used; but if the compressor is provided with an intake duct leading from the outside air the results will be quite different. First, consider the winter condition. Suppose the shop temperature averages 68 deg., and the outside air 30 deg. F. If the air is used at 68 deg. its volume will be considerably larger than the volume taken into the compressor from the outside air at 30 deg. If it requires 1,000 cu. ft. of free air per minute at shop temperature to run the tools, the compressor will have to take in only

$$1000 \times \frac{30 + 460}{68 + 460} = 1000 + \frac{490}{528} = 929$$

which is a saving of over 7 per cent. in air capacity, speed and horsepower. In summer, when the outside temperature is practically the same as the temperature indoors, there would be no saving by using the intake duct, except, as is often the case, when the compressor takes its air supply directly from the hot engine room. Thus, it is seen that the compressor would run at a speed about 7 per cent. lower in winter than in summer. The colder the climate, the more pronounced this effect would become.

An actual case where the application of an intake duct to a compressor represented an appreciable saving recently came to the writer's attention. An air compressor furnishing an average of 2,500 cu. ft. of free air per minute to a machine shop took its supply

from the basement of the engine room, where all the year round the air, heated by a network of steam pipes, averaged 95 deg. F., while the shop averaged 70 deg. F. During the winter months the outside air averaged 32 deg. F., and in summer 70 deg.

Based upon the average consumption of 2,500 cu. ft. per min. for 10 hr. a day, the air used amounted to an average of

$$2500 \times 60 \times 10 = 1{,}500{,}000 \textit{ cu. ft.}$$

per day at the shop end.

As the compressor-intake temperature averaged 95 deg. F., the compressor was obliged to run fast enough to take in

$$1{,}500{,}000 \times \frac{95 + 460}{70 + 460} = 1{,}500{,}000 \times \frac{555}{530}$$
$$= 1{,}570{,}500 \textit{ cu. ft.}$$

of engine-room air per day.

The cost of compressed air in this plant was found to be 2.8c. per 1,000 cu. ft. of free air at the compressor. Thus the cost of furnishing air to the shop was

$$\frac{1{,}570{,}500}{1000} \times 0.028 = \$43.97 \textit{ per day}$$

By putting in an intake duct and furnishing air to the compressor at 30 deg. F. in winter, the compressor could have run slower and would have had to take in only

$$1{,}500{,}000 \times \frac{30 + 460}{70 + 460} = 1{,}500{,}000 \times \frac{490}{530}$$
$$= 1{,}387{,}000 \textit{ cu. ft. per day}$$

At a cost of 2.8c. per 1,000 cu. ft. at the compressor intake, the average cost of air for the plant during winter would then be

$$\frac{1{,}387{,}000}{1000} \times 0.028 = \$38.84 \textit{ per day}$$

During the summer, when the outside and inside temperatures both averaged 70 deg. F., the compressor would take in only the amount used in the shop, or 1,500,000 cu. ft., which at the cost of 2.8c. per 1,000 cu. ft. at compressor intake would be

$$\frac{1{,}500{,}000}{1000} \times 0.028 = \$42 \textit{ per day}$$

With the intake duct in use we then have a daily cost for air of $38.84 for winter and $42 for summer. The average for the year may then be taken at $40.42 per day, as against $43.96 with the compressor taking air from the engine-room basement.

During a working year of 300 days, the annual cost for air would then compare:

Without intake duct....$43.96 × 300 = $13,188
With intake duct....... 40.42 × 300 = 12,126

Giving a net saving with the duct of. $1,062

Capitalized at 10 per cent., this would justify installing an intake duct costing $10,620. As this figure approaches more nearly the cost of the compressor than it does the cost of the duct, the conclusion is obvious.

Incidentally, the saving of $1,062 per year amounts to more than 8 per cent. of the yearly cost for air. It certainly looks worth while to install an air-intake duct under such conditions.—*Power.*

EXPLOSION-PROOF ELECTRIC MOTORS

Among its investigations dealing with the means of lessening such dangers as attend the use of electricity in the mining industries, the Bureau of Mines has undertaken one that has for its purpose the establishment of permissible explosion-proof motors for use in places where an electric spark or flash might ignite inflammable gases or dusts.

Technical Paper 101, "Permissible Explosion-Proof Electric Motors for Mines; Conditions and Requirements for Tests and Approval," which has just been issued, mentions the details of construction that the bureau considers essential for satisfactory service and describes tests of an explosion-proof mining-machine motor and accessories approved by the bureau. The author of this paper is H. H. Clark, electrical engineer.

The Bureau of Mines has applied the term "Explosion proof" to motors constructed so as to prevent the ignition of gas surrounding the motor by any sparks, flashes, or explosions of gas or of gas and coal dust that may occur within the motor casing.

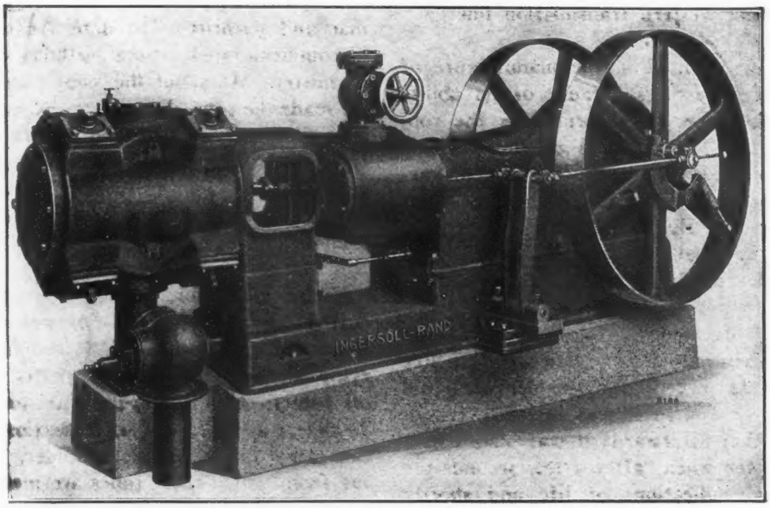
Before it undertook to establish a list of permissible motors the bureau made a large number of preliminary tests. No motors were approved as a result of this preliminary investigation, for none of the motors tested was considered to possess the characteristics of permissibility. As a direct result of these preliminary tests, however, the bureau decided to make tests to establish a list of permissible

explosion-proof motors, and issued its Schedule 2, "Fees for Testing Explosion-Proof Motors." This schedule gave the general conditions under which motors could be submitted for test and the fees to be charged for making such tests. Technical Paper 101 sets forth more fully than Schedule 2, the details that the bureau considers essential to satisfactory explosion-proof motor construction.

The paper gives the requirements for approval of motors, outlines the nature of the approval of the bureau and describes the approval of an explosion-proof coal-cutting equipment.

ler" line. They present high speeds, give high compression efficiency, are almost silent in operation and require no operating mechanism.

Before adopting the "Ingersoll-Rogler" Valve a thorough test was conducted to determine the life of this type of valve. This test consisted in running a 12" stroke compressor at 400 revolutions per minute continuously over a period of one year, during which time no valves were broken nor any adjustments required, and in the two years since that in which this type of valve has been on the market practically no breakage has resulted.



AN UP-TO-DATE AIR COMPRESSOR.

A SMALL AIR COMPRESSOR OF HIGH EFFICIENCY

The constant demand for higher efficiency and greater economy, and the increasing tendency towards the use of higher steam pressures, has led to the development by the Ingersoll-Rand Company of the small steam driven high speed air compressor illustrated above.

This machine is designed along the same lines as the company's former small steam driven type, but embodies many improvements which give it a higher efficiency in the air end and a considerably lower steam consumption.

These improvements are:

"Ingersoll-Rogler" Air Valves. These valves are now standard on the company's extensive line of steam, power and electric driven compressors known as the "Ingersoll-Rogler" line.

Balanced Piston Steam Valves. This type of steam valve also was adopted after extensive research. It is designed after the most successful European practice, permits of higher speeds, high steam pressures and the use of superheated steam, at the same time giving a higher efficiency under ordinary low pressure steam conditions.

Automatic Cut-off Control. Giving the highest possible steam economy under conditions of varying load or varying steam pressures. This control is regulated by a centrifugal fly wheel governor which operates to shorten or lengthen the stroke of the piston valve, thus changing the cut-off.

Automatic Splash Lubrication, by means of which all wearing parts are copiously and continuously oiled.

Enclosed Construction and Removable Cov-

ers, make for cleanliness with great accessibility.

The automatic cut-off control is supplemented by an air unloader, assuring great economy while possessing a high degree of automatism, which is essential in a small compressor designed for severe duty, and generally subject to considerable neglect.

NOTES

California has 110 reservoirs for hydroelectric purposes, with storage capacity of 235,780,000,000 gallons.

Current at a pressure of 150,000 volts is carried on some western transmission lines.

Magnesium is used in the manufacture of sound copper castings because of its ability to decompose the gases formed by the copper in melting. The principal gas thus formed, carbon monoxide, is attacked by the magnesium, forming the two solids, carbon and magnesium oxide. By the use of magnesium, therefore, in small amounts, the production of blowholes in the casting is eliminated.

Popular Mechanics states—without any when or where, as is its practice—that a live gold fish was placed in a tumbler of liquid air, where of course it was instantly frozen solid, and that afterwards it was placed in a glass of water when "after a few seconds the fish showed indications of life and shortly commenced swimming around as lively as if nothing had happened."

With sixty million barrels of crude petroleum "above-ground"—stocks-on-hand, California oil producers offer a guarantee to manufacturers, hotel proprietors and steamship owners that they need have no fear of an oil shortage, but can install oil-burners at once. In addition, many wells in the State are "capped," awaiting better market conditions before being again added to the list of producers.

The third annual joint field meet of the U. S. Bureau of Mines, the American Mine Safety Association and the California Metal Producer's Association will be held at the Panama-Pacific Exposition, September 23 and 24. It is expected there will be a large attendance of mining men, as the joint meet will precede or follow the annual meetings of a number of institutions allied to the mining interests.

Recent tests show that the average candlepower hours obtainable from tallow or wax candles for one cent are 2.68. With a good tungsten filament lamp 120 candle power hours may be procured for the same sum, and with a gas filled tungsten 192.3 candle power hours are assured.

The discovery of oxygen is generally credited to Dr. Joseph Priestly, an English clergyman and scientist. The date, August 1, 1774, is commemorated as the birthday of modern chemistry. At about the same time two others made the same discovery: Scheel, a Swedish apoethecary, who called it "fire air;" and Lavoisier, a French chemist, who called it oxygen, meaning "acid former." To Lavoisier is due the credit for the true explanation of combustion.

Under the trade name "Flexoid," heavy coated canvas tubing is being put out by the Bemis Bros. Bag Co., of St. Louis, for carrying air into tunnels and shafts or taking off fumes, etc. It is put up in 10- to 24-in. diameters and 100- to 500-ft. sections; a man can carry 100-ft. on his shoulder. The canvas from which these tubes are made appears to be rendered air-tight and waterproof by a rubber coating applied to one side and forced partly through the fabric.

Electric consumers in Pasadena, Calif., had to pay 15c. maximum per kw.-hr. up to 1908, when the city erected its own plant. The private company began its fight against the city by a reduction to 12½c. The city began operations with an 8c. rate; the private company met it. In 1910 the city made its lighting price 5c. maximum with a wholesale rate of 3c. and a power schedule of from 4c. to less than 1c. It is estimated that the saving to the city has been $100,000 per year since the plant was established.

There are nearly a hundred thousand employes in the collieries of the anthracite coal fields of Pennsylvania who *mine no coal*. The exact number in 1913, the latest figures avail-

able, was 96,991. The men who mine and load the coal are the miners with State certificates and the miners' laborers. There were 44,346 miners in 1913 and 33,973 miners' laborers. Thus the army of men who are employed at ventilation, transportation, drainage, maintenance, and the preparation of the coal for market outnumbers by over 18,000 the men who are actually mining and loading coal.

Sand imported from Europe is being used in construction of the new subways in New York City. This is not because suitable sand cannot be obtained in this country, but because the war in Europe has cut down the cargoes which steamships ordinarily bring to such an extent that it is necessary for many to come over in ballast. They have been using beach sand as ballast. Upon arriving in New York this ballast is discharged and is practically given away to anyone who will haul it away. Rodgers & Hagerty, Inc., have used ten scowloads of this sand in back-filling what remains of the subway excavation.

An instrument for measuring the quantity of impurity in the air of a room or shop is the result of the inventive ingenuity of a German scientist. It consists of a glass bulb containing a red liquid which turns white on contact with carbonic acid gas. The liquid in the bulb is kept from the air; but once in every one hundred seconds a drop, drawn automatically from the bulb through a bent tube, falls upon the lower end of a stretched cord and begins slowly to descend the cord. If the air be foul with carbonic acid, the drop turns white at the upper end of the cord, and the purer the air the farther the drop descends before changing color. Alongside the cord runs a scale, like that of a thermometer or barometer, indicating the degrees of impurity of the atmosphere.

Henry Gardner studied mining engineering at Freiberg and later at Columbia. Soon after the outbreak of the war he enlisted in the British army, and went to the front. It is told of him that after serving as a private in the trenches for about six months, some sapping plans were inaugurated at the point where he was. Therein his mining experience played a useful part, of course, and attracted the attetnion of his superiors, who obtained the idea that such knowledge could be employed better than in the ranks. Consequently young Gardner was sent home for a little training in military engineering, after which he was returned to the front with a commission.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 4.

1,137,751. VACUUM-PUMP. WOLFGANG GAEDE, Freiburg, Germany.

1,138,083. ROTARY FAN. WILLIS H. CARRIER, Buffalo, N. Y.

1,138,109. AUTOMATIC DEVICE FOR CONTROLLING THE SPEED OF TRAINS. LAWRENCE WESLEY HORNE and WARREN NOBLE CRANE, New York, N. Y.

1,138,110. GLASS-MELTING TANK-FURNACE. GEORGE E. HOWARD, Butler, Pa.

1. In apparatus of the class described, the combination of a glass melting tank, having a discharge opening, a hood, there being means of communication between said hood and the main supply of glass in said tank, means for opposing return flow of the glass through said communicating means, and means for varying the fluid pressure in said hood, whereby the level of glass therein may be raised above the normal level and means for thereafter depressing the level within the hood to cause a discharge of the glass from said tank through said discharge opening.

1,138,125. FLUID-EJECTOR. MAURICE LEBLANC, Auteuil, Paris, France.

1. An ejector device for compressible fluids, comprising an admission nozzle for motive fluid, a mixing cone receiving fluid from said nozzle and having a lateral discharge aperature formed therein at a point intermediate its ends for discharging excess fluid during the operation of starting the device, and a divergent nozzle communicating with the outlet of said mixing cone; the outlet of said discharge passage communicating with the region into which said diffuser discharges.

1,138,165. CRUDE-OIL BURNER. CHARLES WIRTH, Scranton, Pa.

1,138,179. PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,138,193. AIR-BRAKE SYSTEM. PATRICK COERFORD, Victoria, British Columbia, Canada.

1,138,199. REGULATOR FOR FLUID-COMPRESSORS. WILLIAM MACFARLAND DONALDSON, New York, N. Y.

1,138,202. APPARATUS FOR PURIFYING WATER BY MEANS OF OZONIZED AIR. GEORGE ERLWEIN, Berlin, and CHRISTOPH KNIPS, Charlottenburg, Germany.

1,138,206. PNEUMATIC - DESPATCH - TUBE-APPARATUS. EDMOND A. FORDYCE, Boston, Mass.

1,138,209. PERCUSSIVE TOOL. ARTHUR H. GIBSON, Easton, Pa.

1,138,214. ATTACHMENT FOR ROCK-DRILLS FOR SUPPLYING WATER THERETO. CHARLES HANSEN, Johannesburg, Transvaal, South Africa.

1,138,215. AIR-COMPRESSOR. HAVELOCK HARFORD, Port Alberni, British Columbia, Canada.

1,138,248. DEVICE FOR AERATING LIQUIDS. HARRY VAUGHAN RUDSTON READ, London, England.

1,138,266. PROCESS OF TREATING HYDROCARBON OILS. CHARLES H. WASHBURN, St. Louis, Mo.

1. The process of treating kerosene and heavier products of petroleum, which consists in

placing the petroleum product and water into a retort, converting them into vapor, and leading off the vapor to a condenser, the terminal of which is closed to create a back pressure against the vapor, thereby condensing the vapor under a pressure of from three to five atmospheres maintained in both the retort and the condenser.

1,138,278. PRESSURE-CONTROLLED VALVE. JOHN H. CASTLE and WILLIAM G. ROGERS, Painted Post, N. Y.

1,138,359. AUTOMATIC TRAIN-PIPE COUPLING. VOTAW S. DURBIN, St. Louis, Mo.

1,138,380. PROCESS OF PRODUCING SOLUBLE MILK-POWDER. GORDON DON HARRIS and JAMES S. POLLARD, Bayonne, N. J.

1. The process of dehydrating or desiccating milk which consists in spraying the milk while at a temperature of substantially 98° Fahrenheit into the warm dehydrated air having a temperature of substantially 98° Fahrenheit, and then continuing the dehydration of the milk by subjecting the sprayed milk to warm dehydrated air having a temperature of substantially 98° Fahrenheit.

and designed to be automatically actuated by the wheel attached to said axle to operate a signal when the vehicle is rounding the curve.

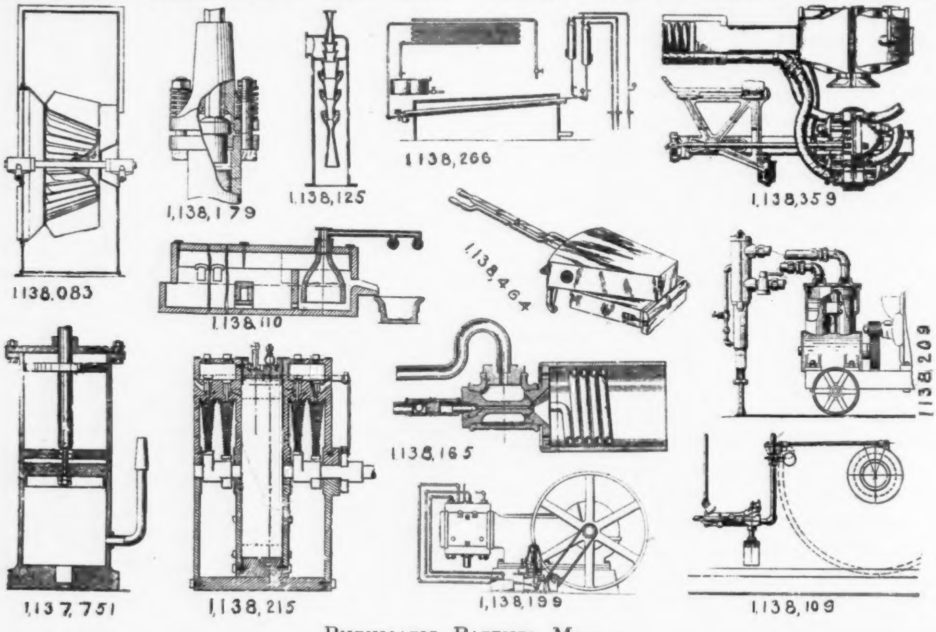
1,138,806. PNEUMATIC WASHING APPLIANCE. MARCUS L. SMITH, Scranton, Pa.

1,138,849. INDIVIDUAL PNEUMATIC-ACTION MECHANISM. WILLIAM F. DEITEMEIER, San Francisco, Cal.

1,138,877. PNEUMATIC HAMMER. DELPHIS T. LELOIS, Chicago, Ill.

1,138,886. VARIABLE-CAPACITY COMPRESSED-AIR ENGINE. BRUNO V. NORDBERG, Milwaukee, Wis.

3. In a variable capacity compressed air engine adapted to be converted from a motor into a compressor at will and provided with means for varying its capacity as a compressor from zero to full capacity, the combination with a cylinder having a by-pass, of a valve normally closing said by-pass, means actuated by the engine for opening said valve at the limits of the piston stroke, and means for rendering said valve opening means operative when the engine has reached its full capacity working under normal conditions as a compressor, to increase the work of compression.



PNEUMATIC PATENTS MAY 4.

1,138,464. PUMPING MECHANISM FOR VACUUM-CLEANERS. HOWARD ECKEL, Los Angeles, Cal.

1,138,612. ROCK-DRILL. MOSES ARTHUR KNAPP, Oakland, Cal.

MAY 11.

1,138,617. PUMP FOR VACUUM CLEANING SYSTEMS. GEORGE B. BARTLEY, Detroit, Mich.

1,138,749. BALL INFLATOR AND SEALER. ALLEN AYRAULT GREEN, Galesburg, Ill.

1. In a device of the character described, an air-tube, a spring-actuated air-inlet valve associated therewith, an air-pump in communication with said valve, a cement nozzle having its outlet adjacent that of the air-tube, and a cement-injector for forcing cement through said nozzle.

1,138,801. HORN-BLOWING ATTACHMENT FOR AUTOMOBILES. WILLIAM W. SCOTT, Plant City, Fla.

1. In an automatic signaling device, a frame, means for removably attaching said frame to the axle of a vehicle, a tube removably carried by said frame and means carried by said tube

1,138,893. STEAM VACUUM-PUMP. JOHN G. ROBINSON, Melrose, Mass.

1,138,969. FLUID-PRESSURE MOTOR. CHARLES J. OLSON, Muskegon, Mich.

1,139,066. PNEUMATIC TIME-SWITCH. GEORGE H. PARSONS, Stamford, Conn.

1,139,084. VACUUM RENOVATING APPARATUS. JOSEPH H. TEMPLIN, Philadelphia, Pa.

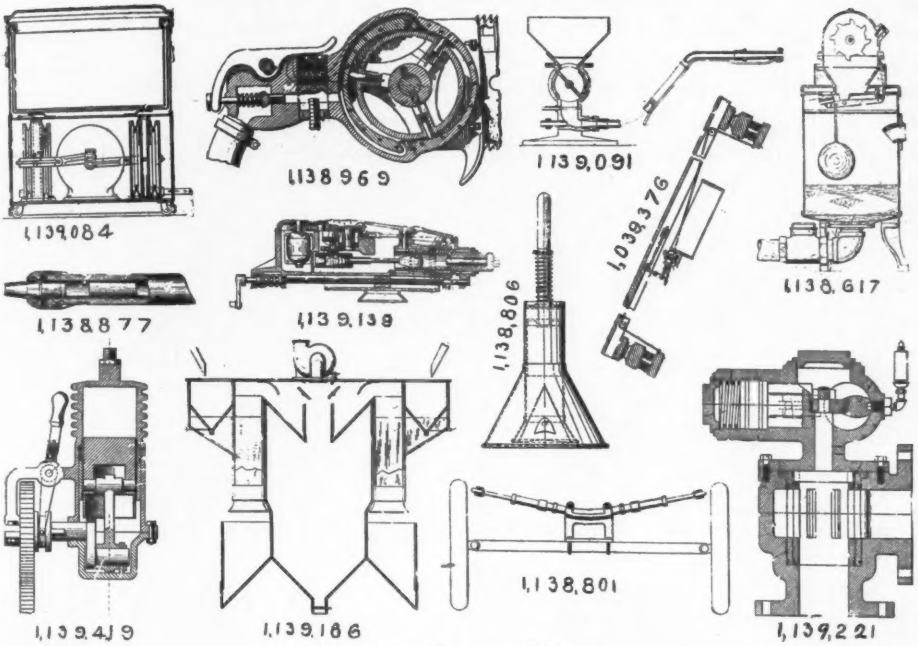
1,139,091. METHOD OF PLASTERING WALL-SURFACES. CARL WEBER, Chicago, Ill.

1,139,139. ROCK-DRILL. WILLIAM L. SMITH, Chicago, Ill.

1,139,186. PNEUMATIC CONCENTRATOR. RENO D. O. JOHNSTON, Nazareth, Pa.

1,139,221. STOP-VALVE. WILLIAM G. POTTER, Marblehead, Mass.

1. A stop valve embodying a casing having an inlet and an outlet passage and a rotary member in said casing adapted to alternately



Pneumatic Patents May 11.

open and close said passages when rotated in either direction, mechanism adapted to rotate said rotary member in opposite directions including a reciprocatory piston and a fluid pressure cylinder in which said piston is adapted to reciprocate, independent sources of fluid pressure connected to said cylinder at opposite ends of said cylinder, respectively, and fluid pressure operated means adapted to lock said piston in a predetermined position.

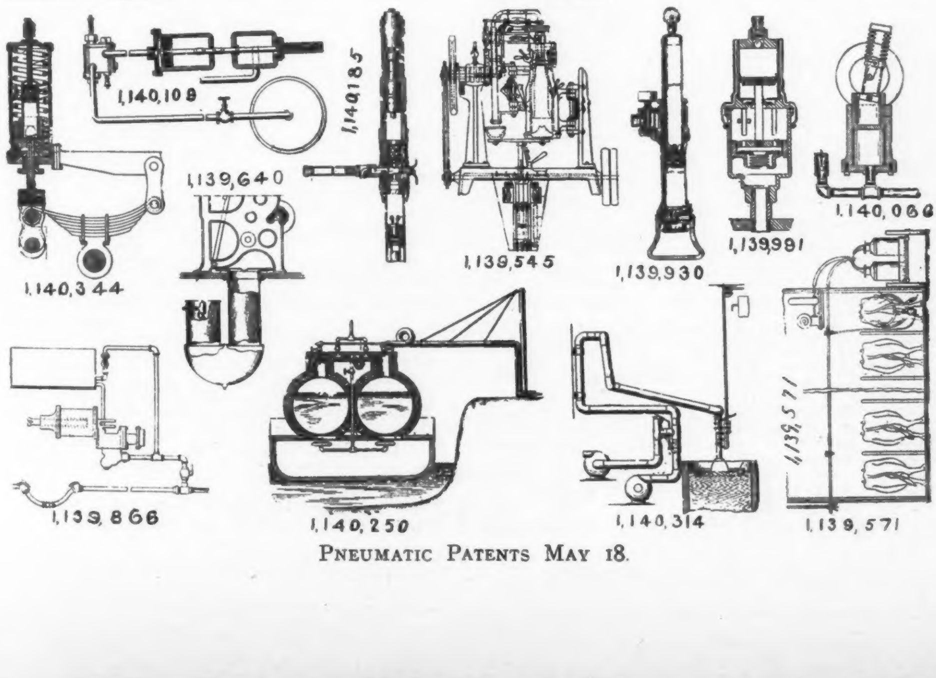
1,139,354. PROJECTILE FOR DESTROYING AIR-SHIPS, BALLOONS, AND OTHER AEROSTATS. Reginald Arthur Featherstone-Smith and Meherjibhoy Bomanji Cooper, London, England.

1. A projectile for destroying airships and the like comprising a shell having an air passage extending therethrough toward the nose end and a gas passage extending therethrough toward the tail end, a gas igniter in communication with the gas passage, openable stops at the exterior of the shell, and an air blower in communication with the air passage.

1,139,358. AIR PURIFIER AND WASHER. Charles A. Geddes, Philadelphia, Pa.

1,139,376. FLUID-PRESSURE BRAKE SYSTEM. William H. Sauvage, New York, N. Y.

1,139,419. AIR-PUMP. Roland C. Hilton, Boston, Mass.



Pneumatic Patents May 18.

MAY 18.

1,139,545. AUTOMATIC MACHINE FOR BLOWING SEAMLESS BOTTLES AND OTHER ROUND VESSELS. George Lefort, Clabecq, Tubize, Belgium.

1,139,571. MILKING-MACHINE. Lewis Preston Paterson, Springfield, Mo.

1,139,589-90. MILKING APPARATUS. George Sinclair, St. Paul, Minn.

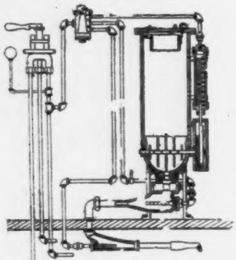
1,139,640. HUMIDIFIER. Frank B. Comins, Newton, Mass.

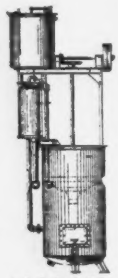
1,139,866. RELEASING MECHANISM FOR AIR-BRAKE SYSTEMS. Nicholas E. Hirsch, San Luis Obispo, Cal.

supporting member, a pair of intercommunicating tanks mounted thereon, heat insulation completely incasing said tanks to retain the contents thereof at predetermined temperatures, means for simultaneously filling the tanks on either side thereof, an insulated pipe connection between said tanks, and expansion valves mounted in the length of said pipe connection for the escape of volatilized contents of said tank, for maintaining said other contents at a continuing low pressure.

1,140,294. VACUUM-CLEANER. Robert R. Smith, Philadelphia, Pa.

1,140,314. GLASS-BLOWING APPARATUS. Pierre J. Paquet, Salem, W. Va.


1,140,618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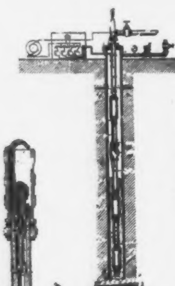
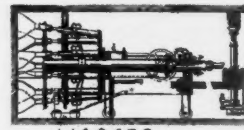

1140,982


1,140,634


1,140,939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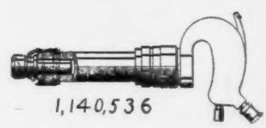
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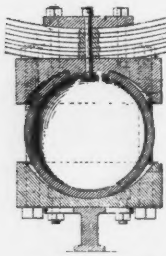
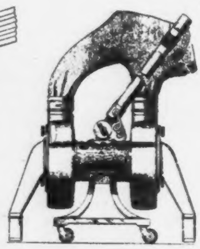

1,140 645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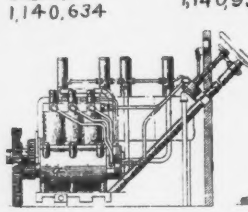
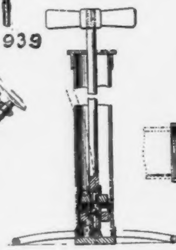

1,140 723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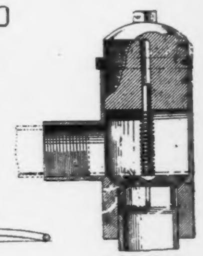
1140,713

Pneumatic Patents May 25.

1,139,910. APPARATUS FOR CLEANING SMOKE TUBES OF MARINE AND OTHER MULTIBULAR BOILERS. Charles H. Shepler and Joseph W. Shearer, San Francisco, Cal.

1,139,930. PNEUMATIC PUMP. Aaron J. Tyler, Rochester, N. Y.

1,139,991. AIR-COMPRESSOR. William Mortimer Melmore, London, Eng.

1. In an air-compressor comprising a pump cylinder seated on the end of an operating cylinder to be connected with one of the cylinders of a motor vehicle, the combination with a pump piston, a rod depending from the piston, a disk-valve frictionally mounted on the piston rod, and means for limiting the travel of said valve, of an operating piston fast to said piston rod and comprising a perforated top plate, a centrally perforated cup-shaped piston body, a non-return valve at the inner face of said plate, and a spring for supporting the non-return valve, as described.

1,140,002. PNEUMATIC CUSHIONING DEVICE FOR VEHICLES. Earl V. Sanders, Pawnee, Ill.

1,140,065. MULTISTAGE COMPRESSOR. Auguste C. E. Rateau, Paris, France.

1,140,066. MILKING-MACHINE. Benjamin P. Remy and Frank I. Remy, Anderson, Ind.

1,140,185. POWER ROCK-DRILL. Frederick Perley Porter, Kellogg, Idaho.

1,140,250. MEANS FOR HANDLING AND TRANSPORTING LIQUID GAS. Godfrey L. Cabot, Boston, Mass.

1. In an apparatus of the class described, a

1,140,344. AIR-SPRING. John G. Funk, Swissvale borough, Pa.

MAY 25.

1,140,373. OXYGEN-GENERATOR. Thomas Griswold, Jr., and Edwin O. Barstow, Midland, Mich.

1,140,536. RIVET-SET RETAINER. Wendel H. Shipeer, New Castle, Pa.

1,140,618. SANDING DEVICE FOR STREET-CARS. William A. Sault, Worcester, Mass.

1,140,634. PNEUMATIC VALVE. Aaron J. Tyler, Rochester, N. Y.

1,140,645. PNEUMATIC CUSHION FOR AUTOMOBILES. Edward A. Wilcox, Carthage, Ill.

1,140,673. TUNNELING-MACHINE. Walter W. Giggey, Netherland, Colo.

1,140,699. AIR-PUMP. John J. Messerli, Kingsville, Tex.

1,140,713. PRESSURE-VALVE. Bingham S. Price, Rawlins, Wyo.

1,140,723. COMBINED AIR-PUMP AND STARTER FOR EXPLOSIVE-ENGINES. Frank E. Ten Eyck, Auburn, N. Y.

1,140,939. PUMPING APPARATUS. Van P. Bailey, Indianapolis, Ind.

1,140,982. OPERATING OIL-WELLS. William D. Huff, La Fayette, La.

1,140,992. PNEUMATIC SUCTION-CLEANER. Emanuel A. Martin, New York, N. Y.

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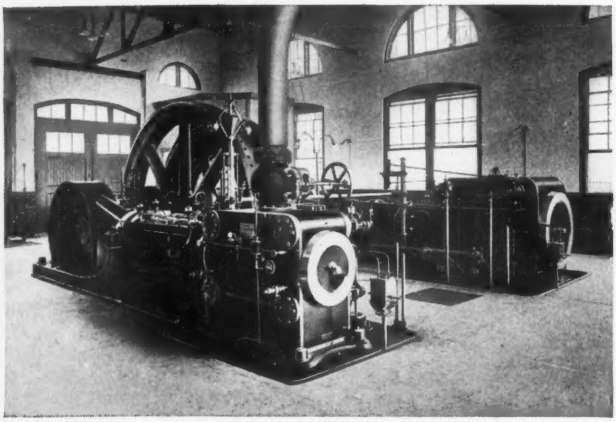

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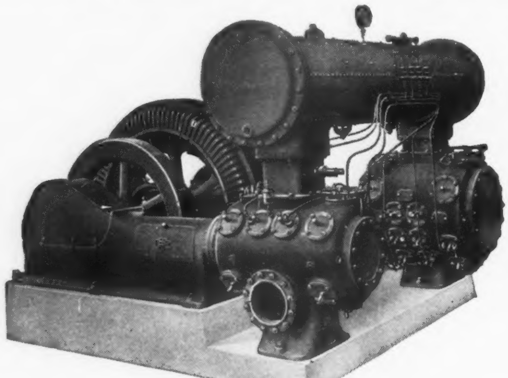

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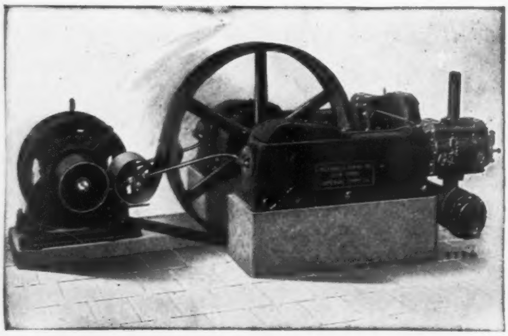

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